DOCUMENTATION ON

DAPS

(Disaster Awareness

in Primary Schools)

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Content

Documentation on DAPS

1. Background Information on DAPS

The Project “Disaster Awareness in Primary Schools” is an effort which is aiming at strengthening risk awareness in Indonesian Primary Schools and to qualify the whole school community to act in a way that the risk of becoming victim is reduced in case disaster strikes.

The events of the 26th December 2004 in Aceh showed to the world that women and children are the most vulnerable if a natural disaster happens. Thus, measures to reduce the risk to become victim were esteemed as necessary to be implemented on primary school level.

In Indonesia many types of natural disasters, e.g. landslides, volcano eruptions, flooding, and earthquakes occur, very often with devastating consequences. Because of the very limited time to develop and implement the project, the team decided in coordination with the partner to focus on earthquakes.

Earthquakes are the most common type of natural hazard in Indonesia as most regions of the archipelago are earthquake prone areas due to the geologic situation of the country. Indonesia is located at the boundaries of major continental plates and because of the continuous movement of the plates (Plate Tectonics Theory) the country experiences the biggest number of earthquakes all over the world.

Indonesian society very often receives any event and especially disasters as something god given or an incident which is caused by supernatural forces. In some traditional tribes for example, an earthquake is believed to be caused by a dragon that lives below the surfaces of the earth and shakes his back when angered. Thus, natural disasters have to be accepted as they are derived as a punishment for wrong behavior or as an ordeal given by god.

This fatalistic attitude leads to a kind of indifference against risk reducing measures and is sometimes even encouraged or exploited by certain groups in order to maintain the status quo.

Consequently it was deemed necessary to provide training in the following areas:

- Background knowledge on causes and impact of natural disasters
- Measures before, while, and after disaster strikes

The project was initiated by the sector project "Disaster Awareness in Primary Schools" and implemented through the team of SEQIP (Science Education Quality Improvement Project) taking advantage of the projects and its consultant’s vast experience and well established structures of doing teacher training.

In general, disaster risk management can be mainstreamed in in-school and out-of-school education, curriculum development and teacher training. The measures are aimed at

a) the recognition and understanding of natural hazards and their significance for people’s personal environment and for social development,

b) the acquisition of knowledge and suitable competencies to take actions in disaster prevention and mitigation in families, schools and communities,

c) the acquisition of knowledge on measures for response to disaster in acute situations

The project experienced unreserved support of the Indonesian partner from the Ministry of National Education on all levels, and in particular on the district level. DAPS was considered a subsidiary project of SEQIP and thus it was not considered necessary to sign a letter of commitment.

1.1. The Projects Framework

1.1.1. Scientific Background Information on Earthquakes

An earthquake is a sudden movement of a part of the Earths' crust and it can cause disaster. Earthquakes result from the dynamic release of elastic strain energy that radiates seismic waves. Earthquakes typically result from the movement of faults within the Earth's upper crust. The Earth's surface is made up by a number of plates which slowly but constantly move. These movements are described and explained in detail in the Plate Tectonics Theory.

These plates slide along each other or move under and above each other in so called subductions zones. Earthquakes happen when the plates get interlocked and stress builds up. The boundaries of the plates are the weakest point of those and so the highest stress is built up here. If the stress is growing too big, it will be released in sudden and jerky movements and an earthquake occurs. In most cases they do so at plate boundaries, much less frequently they do so in the interior of a continental plate.

Earthquakes can also be triggered by volcano eruptions, landslides, through impact from outer space, or can be induced by mankind, for example through nuclear explosions.

The Indonesian archipelago forms a collision zone of three large continental plates, i.e. the India-Australian plate from the south, the Eurasian (South-East-Asia plate) plate from west and east, and the Pacific plate from the east, as well as small plates such as the South-China-Sea plate and the Philippine plate from the north. Therefore geologically the situation in Indonesia is very delicate and it is the region of the earth with the highest frequency of earthquakes.

1.1.2. The Professional Background of Indonesian Teachers

When designing trainings program in any context, the professional background of the target group must be taken into account. In general, it can be said that in any subject the knowledge of concepts of Indonesian teachers is limited, they are very often poorly trained and they have only a very narrow range of teaching methodology at their disposal. In teaching, the teacher asks questions or gives facts and the students answer in a chorus and learn the latter by heart. Understanding of concepts is hardly ever found, and the accumulation of facts as an outcome is the objective of the teaching endeavor.

Basically, the lessons are teacher centered with him or her doing most of the activities, whilst the students are mere receivers of information.

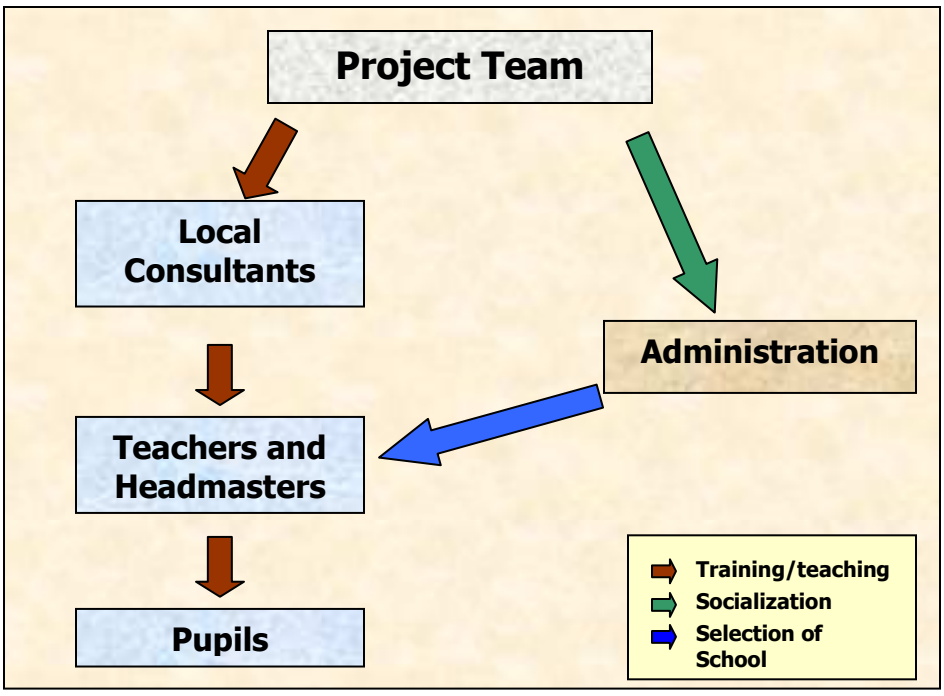
The lesson plans are designed in a narrative manner and what is going on in the classroom mirrors this. Students are listening, they mostly are passive and forms of cooperation like working in pairs or in groups the observer rarely can see.

To change this is a challenging endeavor as it involves a fundamental change in the approach to teaching. It only can be achieved in a long term effort over a lengthy period of time as it is the experience of SEQIP. The SEQIP-team which has implemented teacher in-service training for many years knows from experience that a change in the behavior of the teachers can only be achieved through a long-term and sustainable process.

1.1.3. Consequences for the Project Design

The considerations above bear some basic implications for the project design. The trainings modules cannot be designed in way which over demands the capabilities of the addressees but have to be written in a narrative way as well. Information could not be jotted down in key points in a given format but must be elaborated with describing all the steps in detail. Despite of that, as the focus of the project is on risk management and disaster mitigation, many practical activities have been included like behavior while and after an earthquake and a First Aid course. The project applied a “learning by doing” approach and all the participants had to undergo all the practical procedures themselves.

1.1.4. The Training System

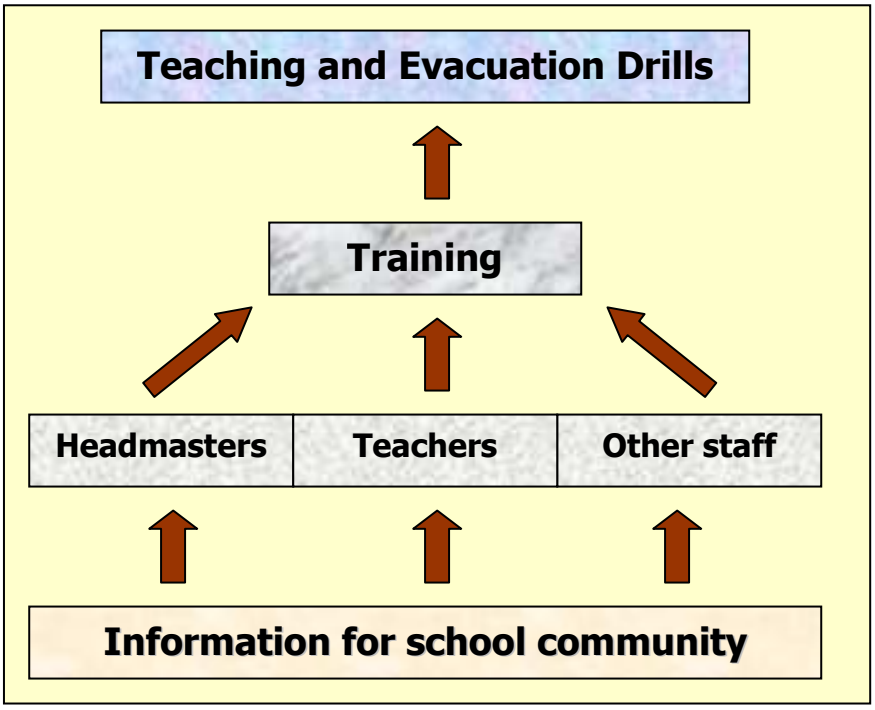


Graphical representation of the project approach

The training system provides an initial training for key persons, i.e. local consultants as disseminators who then train the teaching staff and headmasters in the schools.

The trainers were chosen from the provinces involved to keep the costs of traveling low and to ensure that they are available after the project ended.

The trainings were implemented by teams of trainers (four-eyes-principle) and the maximum number of participants was set to 20. Again, as the experience of SEQIP showed, the bigger the number of participants the lower the quality of the training and hence the results will deteriorate exponentially. The trainees become less and less actively involved and the trainers change more and more to a lecturing style.



The DAPS trainings and information system

In addition, stakeholders from local administration were invited for information seminars to win their support and to select the schools to create ownership.

2. Considerations before Developing the Project

2.1. Objective of the Project

The objective of the project was formulated as follows:

"Pupils in Indonesian primary schools will become aware of their vulnerability through natural disasters and are able to reduce the risk to become victim by taking appropriate measures."

As described above, a natural disaster is widely deemed as an event which cannot be avoided and has to be accepted as it is caused by supernatural forces. This somewhat fatalistic attitude is the reason behind that in most schools preventive and mitigating measures are not

taken or not even considered. In order to overcome this obstacle, a trainings course was designed which gives an insight into the natural forces that trigger an earthquake and which provides information and drills on: “What can be done if disaster strikes?”

2.4. Indicators

The indicators to measure and evaluate the results of the project are:[1]

- A literature study on “How Indonesian Society Copes with Disaster” is written.
- Teaching and learning material including lesson plans and teaching aids are available. by the end of 2005.
- Target group in the project schools are trained by the end of 2005.
- In each project school a coordinator for disaster mitigation management is trained by the end of 2005.
- In each project school an emergency plan is designed by the end of 2005.

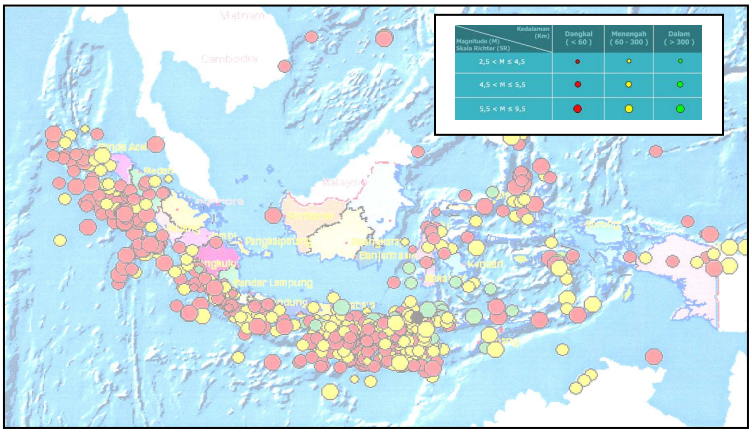
2.5. Main Activities

The main activities were as follows:

- Information workshops studying project related materials which were deemed suitable for the development of a trainings course.
- Development of a trainings course that refers to the professional background of the teachers and the necessities of the schools.
- Training of Trainers (ToT).
- Implementation of the training in 162 schools.
- Evaluation workshop.

Plan of Operation can be found in Annex 1

2.4. The Project Area



Districts and Provinces Taking Part

1. **Lampung Barat (Lampung}**
2. **Kulonprogo (Yogyakarta)**
3. **Gunung (Yogyakarta)**
4. **Bengkulu (Benkulu)**
5. **Seluma (Benkulu)**
6. **Muko-Muko (Benkulu)**
7. **Kupang (East Nusa Tenggara)**
8. **Cilacap (Central Java)**
9. **Puworejo (Central Java)**
10. **Pacitan (East Java)**
11. **Banyuwangi (East Java)**
12. **Blitar (East Java)**

Source: Bidang Gempabumi (Pusat Gempa Nasional) - Badan Meteorologi danGeofisika (BMG)

[1] It has to be noted that the indicators could not be determined in terms of numbers as it was difficult to estimate the costs for the training of one school at the start of the project.

As can be seen from the map, almost all of Indonesia is at high risk of earthuakes. The numbers in the map give the location of the target district.

3. Implementation

3.1. Information Workshops on Material Suitable for the Project

In a first workshop related material was looked through to assess and evaluate which of that was suitable for designing a trainings course. It was found, that the bulk of the material focused on volcano eruptions and tsunami, the latter of course because of the events of the 26th December 2004. In particular the materials on tsunami were often of low quality as they seemed to have been thrown on the marked quickly for economic reasons.

One trainings course was available from the Institute of Technology (ITB) in Bandung which specifically addressed the objective of the project. After studying this, it was found that it was completely unsuitable for the needs of primary schools as it required some sound knowledge in geophysics, mathematics and engineering, and especially the risk mitigating measures were only a minor topic. In addition, no appropriate strategies to get the approach into the classroom could be found.

Considering all this, it was decided by the project team to develop and design a completely new trainings course taking advantage of the implementation approach of the SEQIP, i.e. team of trainers, small trainings groups (< 20 participants), cascade system, support system.

3.2. Development of the Trainings Course

3.2.1. The Project Team

For developing a trainings course and for writing the modules, a team of professionals was established. This consisted of resource persons with a scientific background and those from SEQIP who have a great experience in writing modules for trainings courses which are suitable for primary school teachers. These professionals were put together in pairs and each pair had to write one or two modules. After this another pair did peer- and proof reading.

The advantages of this approach were as follows:

- The resource persons made sure that the content of each module was scientifically correct.
- The SEQIP consultants made sure that the content was simplified enough but not scientifically falsified, thus making sure that they could be understood.
- The modules were written in a way that took the professional background of the teachers into consideration.

Whenever needed, further professionals were contracted, for example to design handy and esthetic teaching aids like pictures and posters.

The trainings course was to be developed within two month as the deadline for the project was the 31st December.

The project team and their professional background can be found in Annex 2

3.2.3. Content and Design of the Modules

All teachers, the headmasters and other staff had to be involved into the training, because an earthquake can happen anytime. Therefore, all school staff had to be trained to enable them to take the appropriate action. Considering that, the course had to be as short as possible because classes had to be cancelled during the training. The project team agreed that a three days course was the minimum period to achieve a sound and sustainable impact.

The following topics were considered to be of relevance and thus modules were written accordingly:

- **Module 1:** Natural Disasters and their Causes
- **Module 2:** Earthquakes and their Impact
- **Module 3:** Early Symptoms of Earthquake Disasters and Measures that should be Taken
- **Module 4:** How to Make Self-Rescue Evacuation Maps
- **Module 5:** What must be Done During and after an Earthquake
- **Module 6:** Procedures and Tools for First Aid
- **Module 7:** Role of the School Community in Dealing with Earthquake Disasters
- **Module 8:** Earthquake Disaster Management at Home

In order to make the impact sustainable, it was considered necessary to involve the whole school community and the parents. Because of that, a special module was designed which addresses the parents and gives information about the project and the risk reducing action to be applied at home in case disaster strikes (module 8).

All modules were designed in a format which has proven to be suitable and included the following steps:

- Tools and Material
- Objectives of the Session
- Trainings Steps
- Background Information
- Learning Activity

The experience of SEQIP showed that each module should be written in a way that it can be used on each level of the trainings cascade as resource and reference material which can easily be adapted to the needs of the respective target group. By doing so it was made sure that the loss of quality on each level was minimized as far as possible.

Complete modules can be found in Annex 3

3.3. Literature Study on: "How Indonesian Society Copes with Disaster"

To prepare the trainers beforehand against possible objections, a study on the topic "How Indonesian Society Copes with Disaster" was done by Dr. Bambang Shergi Laksmono, MSc. from the University of Indonesia, Faculty of Politics and Social Sciences". It was found that animism, believe in supernatural forces and fatalism are widely spread in Indonesian society

and that natural disasters were accepted as something which was imposed on society as punishment and reminder. The results of the study were presented to the trainers. After lengthy discussions, it was decided that this attitude could not be changed with the given possibilities and within the limited time of a trainings course (3 days only).

Despite of that, it was agreed that through suitable measures it would be possible to change this attitude, from being fatalistic to a behavior suited to the situation.

For terms of reference see Annex 4

3.4. Socialization Workshops

To win support and to select the schools to be trained, responsible staffs from the sub-district administration of education were invited to a socialization workshop. These staffs were Primary School Inspectors and Heads of Primary School Division of District Education Authority (Kasubdin). After being informed about the objective and the approach of the project, the participants in this workshop were very enthusiastic and interested and expressed the idea to enlarge the project area even at the expenses of their own budget.

Program can be found in Annex 5

3.5. Training of Trainers (ToT)[2]

All the 24 trainers were selected from the pool of SEQIP consultants which consists of 178 teaching personnel of universities with either a professional background in biology or physics. Selection criteria were as follow:

- Professional background in physics
- Minimum 5 years of experience in teachers training
- Location of duty close to the target districts

A “Learning by Doing” approach was applied in the ToT. It consisted of theoretical input, discussion of content and peer teaching activities under the guidance of the project team. This mode of action has proven to be successful and efficient.

It has to be stressed that all the trainees had to undergo all the steps which were later to be taught in the schools themselves like hiding under the table and leaving the classroom in an orderly manner whilst protecting their heads with bags. Taking the socio-cultural background of Indonesian society into regard where the loss of face is a central and decisive factor of social behavior, the latter was only possible because all the participants knew each other very well from many workshops and trainings activities.

Summarizing the activities and results of this workshop, it could be said that the trainees understood and internalized the content of the modules quickly and easily. Thus, a smooth and efficient implementation in the field could be expected.

Program and participants can be found in Annex 6

[2] ATry-Out could not be carried out due to the very short life time of the project

3.6. Implementation in the Field

3.6.1. Training in Schools

In each target district 6 schools were selected and two schools were combined as one trainings group. For the first day of training the school committee was invited to win its support and to create transparency. This was deemed absolutely necessary as the school committee as the representation of the parents is an instrument which supervises, advises and provides funds.

One of the objectives of the training in schools was to create awareness that regular evacuation drills were essential for the risk reducing actions to become routine activities. Therefore, the parents had to become involved. By inviting the school committee for the first day of the training, it was made sure that the information about the training was spread to the parents. It is hoped that this guarantees that the parents through the school committee apply appropriate pressure to the school staff to exercise the drills regularly and thus to make the achievements of the project sustainable. As a side note it was observed that the members of the school committee were very enthusiastic and expressed repeatedly their wish to take part in the full training even though some people had to take leave. This had to be declined as the second and third day contained many practical activities and for reasons of efficiency the trainings group had to be kept small as explained above.

On the third day the pupils came to school. At first only one class as a sample group with which the risk reducing actions and evacuation drill was exercised in a laboratory situation. By doing so, the teachers could observe and practice the procedures, discuss observations and be instructed and corrected by the trainers.

The training on evacuation procedures was divided into fours steps:

I. Watching the video on evacuation from the classroom.
II. Hiding under the table.
III. Leaving the class room.
IV. Assembling in an open field

Pupils protecting themselves under a desk and evacuating an injured class-mate.

After the break all pupils came to school and a full scale exercise was triggered and carried out.

3.6.2. Facts

- 24 persons were trained as trainings consultants
- 162 schools became involved
- ~ 1620 school staffs were trained (headmasters, teachers, other staff)
- ~ 800 members of school committee were informed
- ~ 33000 pupils became involved

3.6.3. Costs

1 consultant including traveling, accommodation and honorarium (3 trainings locations)	450 €
1 trainings location	300 €
1 school	150 €

The figures above include the costs for all the material given to the schools like posters, videos, copies of the modules, and others.

3.7. Monitoring und Evaluation

After the first implementation period the trainers reported data and observations to the project team. The data were analyzed and the observations were grouped.

All this was discussed in an evaluation workshop.

The positive outcomes of the training were summarized as follows:

- In all project schools the training was received extremely well, the teachers considered the suggested teaching activities as feasible and showed great enthusiasm about implementing the activities in their classes. In two project schools one teacher each already had participated in the trainings course provided by ITB, Bandung. Both said that they didn't take any further actions as they found the content far too difficult and they didn't really know what to do. The program designed by GTZ-DAPS was much easier to be understood and applied.
- On many occasions the headmasters conveyed that similar trainings should be designed for other kinds of natural hazards, especially for flooding and landslide.
- One Kasubdin said that he will submit a written proposal to the district government to implement the training in all district schools with their own budget.

Things to be improved:

- In some cases it was considered worthwhile to improve in terms of methodology in order to give an example for teaching in other subjects, e.g. group work.
- The content of module 6 (Procedures and Tools for First Aid) was regarded as to be too full and it was decided to focus on life saving measures in the training only. Therefore the module should be revised.

4. Summary

Given the very limited life time of the project of only five month, it can be stated that the result is extraordinary. This was only possible because the whole project team worked with incredible enthusiasm and professionalism especially in the development stage of the project. Even during Ramadan, the Muslim fasting season, the members of the team never hesitated to work late hours without further remuneration sometimes till 12 o' clock at night. This cannot be appreciated highly enough.

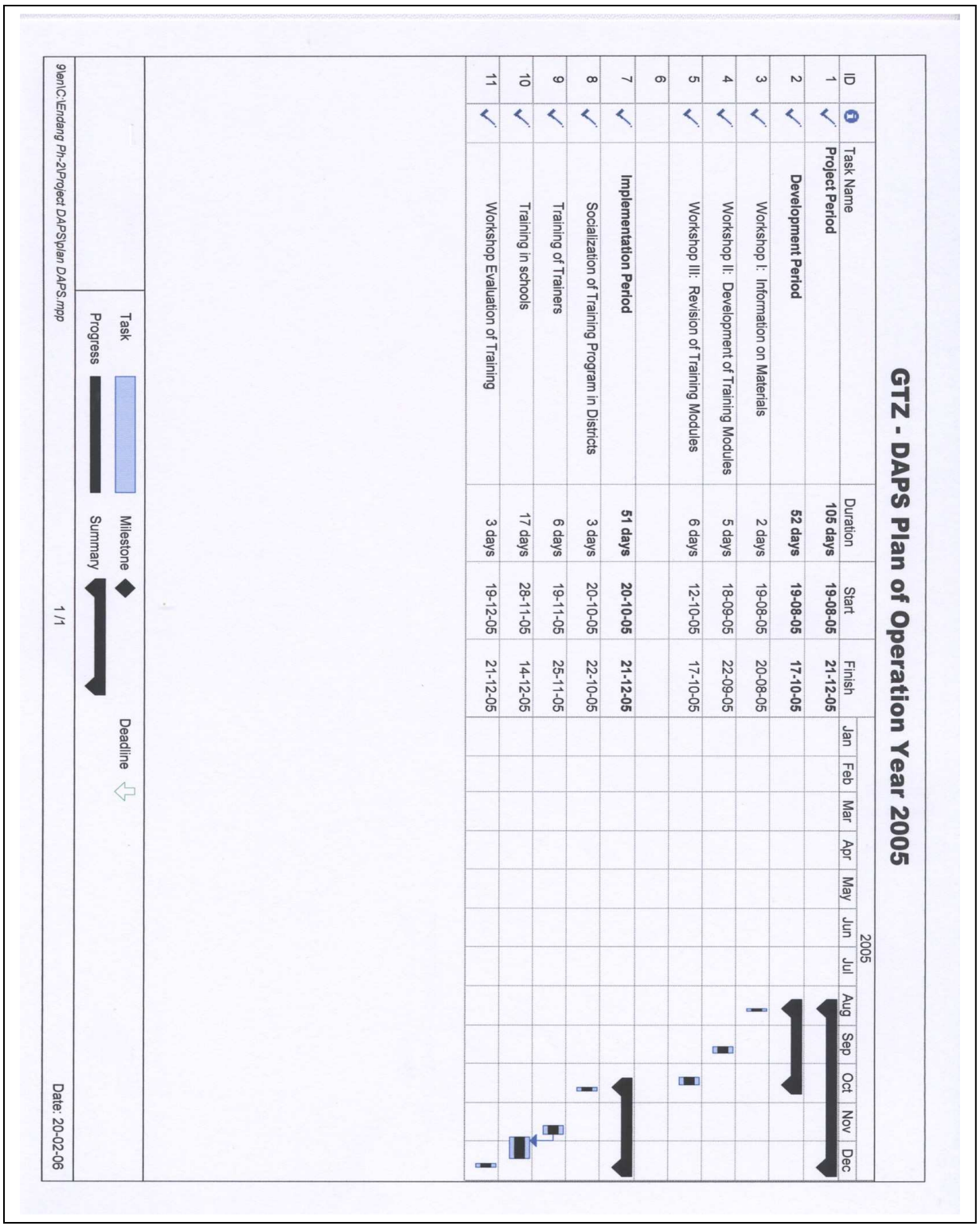
The schools are in sheer need of programs like DAPS because many of the programs for disaster mitigation which are available in Indonesia are either not suitable or never reach the class room.

Because of that, the whole school community was grateful to receive a program which is down to earth and addresses the needs of the target group.

Developing similar programs for other kinds of natural hazards is highly required.

Annexes

Annex 1: Plan of Operation



Annex 2: Project Team

No	Nama	Professional Background
1.	Drs. Joko Sudomo, MA	DAPS Coordinator; Lecturer in Physics Education Department, Faculty of Mathematics and Natural Sciences, State University of Yogyakarta
2.	Dra. Sulistiorini, MA	SEQIP Consultant for the Monitoring and Development of Written Materials
3.	Prof. Dr. Muslimin Ibrahim	Lecturer at the Faculty of Mathematics and Science, State University of Surabaya
4.	Prof. Dr. Soeparman Kardi	Lecturer at the Faculty of Mathematics and Science, State University of Surabaya
5.	Drs. Zainul Asrori, M.Si	Lecturer at the Faculty of Mathematics and Science, Institute of Technology Surabaya
6.	Dr. Ir. Wahyudi	Lecturer at the Department of Offshore Engineering, Faculty of Marine Technology, Institute of Technology Surabaya
7.	Sigit Widdiyanto	Activist in the Komunitas Peduli Bencana, Yogyakarta
8.	Didik S. Mulyana	Activist in the Komunitas Peduli Bencana, Yogyakarta

Annex 3: Modules

Module 1 Natural disasters and their Causes

Competence
Participants will be able to understand the definition of natural disaster, natural disaster types and their causes.

Indicators
1. Participants will be able to desribe in writing the definition of natural disaster in their own words
2. Participants will be able to describe 5 disaster types caused by natural phenomena along with their causal factors
3. Participants will be able to describe 3 disaster types caused by human behavior
4. Participants will be able to identify natural disaster types based on their causes.

Background Information

It is mentioned in the draft Law on Disaster Handling that a natural disaster is an event or a series of events caused by nature, humankind and/or both that occurs abruptly or slowly, resulting in loss of life, vast property loss, disruption of infrastructure or facilities, environment, public utilities, loss of lifelines (both social and economical), as well as loss of access to lifelines.

Natural disaster types can be seen on the following table.

Table 1: Natural Disaster Types

Natural disaster types	Examples
Geological natural disaster	Earthquake, tsunami, volcanic eruption, landslide, ground subsidence
Climatological natural disaster	Flood, flash flood, tornado/hurricane/tropical storm, drought, forest fire (not caused by humans)
Extra-terrestrial natural disaster	Meteorite fall-out from outer space
Natural disaster caused by human behavior	Forest fire, landslide, water pollution
Natural disaster caused by human behavior and natural phenomena	Forest fire, landslide, flood caused by forest denudation

In line with the heading of this module, the discussion topic will focus on natural disasters caused by natural phenomena, even though disasters may also occur

because of human behavior. From the description of disaster definition as mentioned in the draft Law on Disaster Handling, specific natural disasters may occur abruptly or slowly. Natural disasters that occur abruptly include earthquakes, tsunamis, flash floods, windstorms, volcanic eruptions, and landslides. These disasters, due to their sudden occurrence, are very difficult or impossible to forecast.

Different from abrupt natural disasters, as such droughts, famines and environment degradations occur slowly. These disasters naturally have their own causes and characteristics.

Tsunami

"Tsunami" originates from the Japanese word "tsu" which means harbor, and "nami" which means wave. Thus "tsunami" means: "high tidal waves in the harbor". A brief description of tsunami is "Sea waves for long periods caused by a powerful undersea disturbance, such as an earthquake, volcanic eruption, or landslide".

Tsunami waves may originate from three sources: earthquakes, volcanic eruptions, and/or avalanches, all undersea. The velocity of tsunami waves may reach 800 km/hour in the deep sea, but tends to slow down when approaching coastal areas although they are still quite fast (50km/hour) with waves of a height of tens of metres.

Volcanic Eruption

A volcano, when erupting, will pour magma through vents in the earth's crust. Magma that overflows the ground surface is called lava, which contains various material called tephra. Except for magma an erupting volcano also ejects hot ash, which consists of hot steam particles. The destruction caused by a volcanic eruption may come from flowing lava, hot steam waves and ash, as well as debris from lava flowing down the mountain top.

Landslide

A landslide is the shifting of a large quantity of soil, comprising soil, rocks, and a variety of material moving down the mountainside or steep terrain with loose soil, especially during a heavy rainfall.

The main cause of landslides can be blamed on occurrences such as intense rainfall, geological and topographical conditions, as well as triggered by irresponsible human deeds. In short, a landslide may occur due to heavy rainfall, steep terrain, thick and soft soil with unstable rocks, ground shaking, depleting water supply in a lake or dam, increased burden from buildings, erosion, cliff material deposits, and an old landslide.

Flood

In general floods are caused by nature and human behavior. Therefore the solution will not only affect technical aspects but also problems concerning the overall population. Basically, high intensity of rainfall and high tides can increase the frequency and intensity of floods.

With regard to human behavior, very rapid city development and shortfall in drainage facilities, squatter slums alongside canals, littering of canals and rivers, are the main causal factors of floods.

Other than the above, reclamation on marshy land will result in depletion of water supply functions, leading to the slowing down of the water flow and also a higher sedimentation resulting in a water run-off from upstream. This is also the case with excessive use of ground water which may cause soil subsidence and increase the occurrence of floods.

Drought

A drought may occur when the water supply is insufficient to meet the requirements. This disaster is caused by a long period of dry season, which may occur throughout the year, for irregular periods beyond prediction. A drought caused by insufficient rainfall is called a meteorological drought, whereas a drought caused by depleting the water supply is called a hydrological drought.

Windstorm/Hurricane

Geographically, the coastal areas and small islands in Indonesia are quite susceptible against windstorm disasters. A windstorm can reach a velocity of 200 km/hour with wind speeds of up to 200 kg/m2 which makes it powerful enough to tear down buildings and trees.

Windstorms often occur in Indonesia, for instance *angin bohorok* in North Sumatra, *angin puting beliung* in Bengkulu and South Sulawesi, *angin gending* and *cleret tahun* in East Java, and *angin lesus* in Central Java.

Earthquake

Earthquakes do not only strike residential, business, and industrial areas on land, but also hit coastal areas. An earthquake occurs because of sudden shifts in the earth's crust across a fault. The displacement of a fault and motion of the earth's crust may release energy. Whenever accumulated energy in the earth's crust exceeds its carrying capacity, an abrupt release of energy may occur and is called "earthquake". This type of earthquake is called "tectonic earthquake". Ground tremor caused by seismic waves above and under the earth's surface may cause ground fissures, jolts, tsunamis, earthquakes and landslides.

The probabibility of an earthquake can be forecasted, but when it actually occurs cannot be determined. Forecasts are based on the monitoring of seismic activities, observation and the history of earthquakes.

Besides tectonic earthquakes we also know volcanic earthquakes caused by volcanic activities.

Summary

Natural disaster types and their initial symptoms can be seen in table 2

Table 2: Disaster Types and their Initial Symptoms

Disaster Types	Initial Symptoms
Flood	High intensity of rainfall, for long periods, rise in river water levels as recorded by the observation post
Flash Flood	Barren mountainous area, avalanche prone rocks, high intensity of rainfall, long periods of rainfall, upstream damming up
Landslide/Avalanche	High intensity of rainfall, for long periods, land fissures at upper slopes, water seeping like new springs, slanting electric poles, trees and buildings
Volcanic Eruption	Rise in crater temperature, change in chemical composition of water and steam/gas in crater, lava fallout, slight tremor, forest animals fleeing down mountainsides
Tsunami	Earthquake, depleting sea water level, animals fleeing to higher grounds
Earthquake	Increased frequency and amplitude on seismograph, change in animal behavior (usually quiet)

Learning Activities

Tools / Material

- VCD of the tsunami disaster in Aceh and presentation equipment, if available
- Transparencies
- Photos/pictures/newspaper clippings of natural disasters such as tsunamis, earthquakes, floods, landslides (try those already occurring in Indonesia)
- Learning set

Preparation

- Prepare VCD presentation of tsunami, or stick photos/pictures regarding certain natural disasters, in line with those available on the white board.

Learning Steps

Activity I: Discussion / Questions Answers on the Definition of "Natural Disaster"

1. If the VCD of the tsunami and a VCD Player are available, the teacher makes the necessary preparation for the tsunami VCD presentation, and when ready asks: *"Students, would you please pay attention to what I am going to present with this VCD? Good, are you all ready now? Please pay good attention and don't be noisy."* Then the teacher presents the VCD of the tsunami for approximately 5 minutes.

   If the VCD of the tsunami and the VCD Player are unavailable, the teacher shows photos/pictures regarding the impact of tsunamis and other natural disasters to the students. After having finished the VCD presentation or having shown photos/pictures regarding the impact of natural disasters, the teacher says:

4. *"What events have you just seen on VCD or on photos?"* Appoint one of the students whom is raising his/her hand to express his/her opinion. Provide feedback to his/her answer. Ask the other students if they have different opinions. Provide feedback.

3. Teacher: *"Yes, correct, that is the event that not so long ago occurred in Nangroe Aceh Darusallam (NAD). The province called it a "tsunami". Do you know the definition of the term "tsunami"?"*. Give students a few seconds to think about the answer. *"Okay, who knows the definition of 'tsunami'? No one? Now listen carefully to my explanation".*

4. Teacher explains the tsunami definition in line with the background information's written descriptions. Thus, definition of "tsunami" is "high tidal

waves in the harbor" (written on white board). The event is also called "natural disaster"! *"Do you know why it is also called 'natural disaster'?* Give students time to think about the answer.

5. *"Good, who would like to answer". "Still no one? Okay, now remember what you have observed from the pictures/photos or the VCD presentation". "What are the results of tsunami waves which you have seen on the pictures or in the presentation?"* Give time to think, then appoint one of the students who is raising his/her hand. If the answer is incomplete appoint another student.

   "Your answers are correct, tsunami waves would cause a lot of damage to houses, buildings, vehicles, belongings, and even human life, both injuries and deaths".

6. *"How about ricefields, plantations, and clean water supply as lifelines of the Aceh people?"* Give students time to come up with answers, and also provide feedback.

   Can economic activities such as shops, factories, markets, still function the way they used to?True, indeed, the disruption or consequences caused by a tsunami are utmost severe, as to the environment, people and their belongings, livelihood as well as to lifelines.

   Now then, this sort of severe consequence or disruption is called ***disaster****. Thus how about a definition of disaster? Give students time to discuss among themselves, then appoint one student to bring the discussion result forward and write it on the white board. For the sake of time efficiency, the teacher writes the students' answer on the white board.*

7. *"Who can add more to the disaster definition already written on this white board?"* After there is no more addition received from students, the teacher writes up the description of disaster in line with the formulation provided in the background information. Give students time to make notes.

Natural disaster:
• an occurrence or series of events caused by nature, humankind or both, • occurs abruptly or slowly, • causes human casualties, loss of belongings, damage of facilities, infrastructure, public utilities, environment, • causes loss of lifelines, both social and economic, and loss of access to lifelines.

8. *Good, now let us continue our discussion. Can the occurence of a tsunami be caused by human behavior? In that case, what type of occurrence is tsunami?*

Give students time to answer. *Yes, true indeed, a tsunami is a natural phenomenon, and the disaster it causes is called a natural disaster.*

9. *Well, now you have understood the definition of the term "natural disaster".* Ask a student to narrate the natural disaster definition again without referring to any notes. *Good, are there any more questions regarding the definition of the term "natural disaster"?*

10. Based on the definition of "natural disaster", give examples of other occurrences that may be classified as natural disasters. Also ask why the students have those opinions. Give other students the opportunity to provide comments against the comments earlier made. Provide feedback.

11. *If there are no more questions regarding the definition of "natural disaster", let us discuss other matters of no lesser importance than the natural disaster definition.* The teacher proceeds with the next learning activity i.e. "Activity II concerning natural disaster types and their cause".

Activity II Disaster Types and their Causes

A. Earthquake

1. *Earthquakes are natural disasters that frequently occur in Indonesia. The word "earthquake" is certainly not unknown to you. What can you feel or see when there is an earthquake?*

2. *Yes, we will feel trembling, shaking, and things that previously were not moving, are now moving. Did those things move on their own? Indeed, like the saying of a proverb "If there is no fire, then there is no smoke". This means that an event is always preceded by a cause.*

3. *During an earthquake, ground that previously did not move will move. If so, what is the cause of the tremor?* Give students time to think and come up with an answer. *Yes, indeed, the source of tremor lays inside the earth. Discuss this description carefully .*

4. The teacher explains how earthquakes may occur and the different types of earthquakes (tectonic, volcanic).

An earthquake occurs at the moment when there is a strong release of energy, after the displacement of a fault was formed due to friction of the earth's crust/plates.

5. Explain that earthquakes do not always cause disaster, for instance an earthquake that occurs in an area where there are no humans. Proceed with an

explanation regarding the results of a strong earthquake. Use the Nabire earthquake or another earthquake that occurred elsewhere as an illustration.

6. Conclude this learning activity by summarizing the description of the definition of the term “earthquake” again, its cause, and consequences. Ask students: *“What type of earthquake often occurs in Indonesia?”*

B. Tsunami

1. *We have just finished discussing the definitions of natural disaster, tsunami, and several examples of other natural events which can be classified as natural disasters. Now, from the pictures/photos or VCD presentation shown regarding tsunamis, did it occur to you why there is a sudden surge of high tide, which overflows the land with high speed? Or what natural phenomenon may cause a tsunami?* Collect all opinions from the students and do not comment or discuss.

2. *Listen carefully to my question. Are all of you ready now? Good. Sea water that at first looks calm, but suddenly turns into high tide and overflows land at a very high speed, would certainly have a cause. What may the cause be?* Give students some time to think and discuss among themselves. If no one answers, provide the explanation as follows:

3. *If you swim together in a swimming pool, the water level will rise or even overflow. If the seawater suddenly moves and overflows the land at a high speed, there certainly must be an energy stimulation. But where does the energy come from? Or what makes seawater move?* If there is no answer, provide an explanation as follows.

4. *Certainly you still remember the impact of an earthquake. Buildings, houses, trees and other things are trembling as if being shaken. Other than that, an earthquake may result in displacemenst and avalanches along the seabed. This occurrence is the main cause of a tsunami, besides an undersea volcanic eruption.* Write on the white board, and give students time to make notes.

5. *Can an earthquake only occur along the seabed or following an undersea volcanic eruption?* No, of course not. An earthquake can also occur on land, during the eruption of a volcano. Let us discuss this matter.

C. Volcanic Eruption

1. An earthquake may be an indication that a volcano is going to erupt. There is a huge number of volcanoes in our country, therefore the chance of earthquakes to occur is also quite high. When a volcano erupts what does it eject? Give students time to answer.Yes, radiating liquid material, hot fluid rock pouring through seismic vents called magma. Magma that overflows the ground surface is called lava.

Other than magma, what else does an erupting volcano eject? If there is no correct answer, redirect with the question: What do you often see above an active erupting volcano?

Yes, correct, smoke or clouds that certainly must be very hot, comprising hot steam/gas containing various particles.

2. What is the consequence caused by the lava flow and moving hot cloud/ash? Give students time to think, answer, and proceed with a discussion to formulate disasters caused by an erupting volcano. Write the summary on the white board, and give students time to make notes.

3. Now then, a volcanic eruption can result in a disaster and therefore classifies as a natural disaster. The symptoms which precede the eruption of a volcano may indeed be forecasted, but when exactly the volcano will erupt is very difficult to determine.

4. So far we have discussed three natural disaster types, i.e.... (appoint a student to mention them) Yes, correct, natural disasters of earthquake, tsunami and volcanic eruption. Are there any other natural disasters?

   Yes, true, let us now discuss one of them i.e. disasters caused by landslides.

D. Landslide

1. Whenever there is a landslide flowing down a mountainslope, what do you notice from the soil?

Yes, correct, the soil is moving. Does the soil contain other particles? If so, what are they?

2. Yes, besides a large quantity of soil, other things such as rocks, trees, and other material follow along with the soil. Therefore an “avalanche” is defined as **“landslide, comprising soil, rocks, etc”.**

3. Except at mountainslopes, where else do landslides generally occur?

4. Yes, correct, along steep river cliffs and other terrain with soft soil. During what season is the highest probability of landslides?

5. Yes, certainly, during the rainy season, especially when there are prolonged downpours. The question is, why? Because the soil is soft and easily swept away by water. Rocks and other material too, due to the soft soil, are not planted firmly within the soil. If land moves, other things inside it will also move along.

6. Apart from rainfalls, what other factors may cause a landslide? If this is difficult for the students, clarify further; how about human behavior, especially in landslide prone areas, such as a forest edge or a riverbank?

Give students time to think.

7. Yes, human behavior such as forest denudation, cultivation on mountainsides, rock excavation on mountainsides, sand digging on riverbeds. Buildings or too heavy burdens at certain places can also result in a landslide.

> Landslide: Moving soil, comprising large quantities of soil, rocks, etc. due to heavy rainfall or human behavior

8. What are the consequences of a landslide? Collect and discuss answers received from students and make a summary. Write the definition of “landslide”, its causes, and consequences on the white board. Give students time to make notes.

E. Flood

1. Other than landslide, what other disasters may be caused by a relatively long and heavy rainfall? Appoint a student to answer. Yes, naturally floods.

2. Except intense and prolonged rainfall, what else may cause floods? Answers from students may be variable, aim at human behavior.
   Provide another example of human behavior that may result in a flood. Collect opinions from students, discuss, and write a summary on the white board. Give the students a chance to make notes. (See cause of flood written in background information)

3. Certainly it is not difficult for you to write down the consequences of a flood. Make notes in your notebooks.

4. Okay, let us now review a flood disaster.
   a. What is the main cause of floods?
   b. What kind of human behavior can cause floods?
   c. What disasters may occur as the consequence of floods?

5. Let us discuss other natural events which occur during the dry season. .

F. Drought

1. The teacher gives a brief example of what usually happens during a dry season. For the last few years a vast number of certain regions in our country have been experiencing droughts.

2. Droughts are caused by the absence of rainfalls for long periods. Apart from that, another factor that may cause water scarcity is the depletation of the water supply. This relates closely with humankind as the main user of water.

3. A human deed which can lessen water supply for instance is forest denudation so that land becomes barren and unable to preserve water anymore. Thus the water supply will become more scarce. Another cause is the excessive use of ground water.

4. Possible disasters resulting from droughts are for instance insufficient water for humans and other organisms; crop harvests tend to fail leading to food scarcity and even famine, specific illnesses such as hunger oedema.

G. Windstorm/Hurricane

1. The teacher gives brief information regarding windstorms accompanied by heavy rainfall.

2. In certain areas the occurrence is called “whirlwind gale” (*angin lesus*), hurricane, sometimes the following names are also used: *angin puting beliung, angin gending*, etc. Other terms are “typhoon”, “storm”.

3. Tacher explains a windstorm, that the larger the difference in air pressure between two places, the stronger the wind blows.

4. In the tropics, air is hot, humid, and low pressurized. This condition makes it susceptible for hurricanes/typhoons/windstorms to occur.

5. Write disaster risks that may occur as the consequences of a hurricane/typhoon/ windstorm.

Summary

Review descriptions of each respective natural disaster as discussed in this module, through questions and answers, including:

1. Definition of each respective disaster type
2. Its causes
3. Its consequences

Make sure that all participants have understood.

Assessment

1. Explain in writing the definition of disaster in your own words!
2. List 5 natural disasters and each respective causal factor!
3. Explain three disasters caused by human behavior!

4. Here are descriptions regarding the cause of natural disasters, write types of natural disasters according to causal description in the boxes below!

Cause	Types of possible disasters
a. Movement of earth's crust/plate	a.
b. Strong earthquake along the seabed	b.
c. Huge difference in air pressure in two places	c.
d. Heavy rainfall, for long periods, instability of land structure, slanting	d.
e. Excessive use of ground water, prolonged dry season	e.

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Module 2 Earthquakes and their Impact

Tools and Material:

- Handbook (handout)
- Transparencies (handout)
- Epicenter map and map of earthquake prone regions
- Map of Indonesia
- Map dividing continents
- Overhead-projector (OHP)
- Paper and writing material
- Sand-paper and a glass

Trainer: DAPS Consultant

Objectives

Participants will be able to:

1. Understand the definition of „earthquake“, earthquake types and causes.
2. Understand the natural phenomena that accompany earthquakes.
3. Understand and show earthquake prone regions in Indonesia on the map.
4. Understand the impact caused by earthquakes.

Training Steps

A. Initial Activities

1. Teacher shows pictures regarding natural disasters caused by earthquakes, and then asks: *What do you see on these pictures and what could have caused this damage?*
2. The teacher should focus on the answers naming earthquakes as the cause of the damage.
3. Teacher asks students: *„Who among you has ever experienced, felt, heard or seen an earthquake? “* Then appoint one student to tell about his/her experience in front of the class.
4. Well, now we will learn how an earthquake occurs and what impact it is causing.

B. Core Activities

1. Invite participants to study the map which is dividing the world and think how this can happen. The teacher asks participants why this can happen.
2. Invite participants to study the map and imagine about high places (Himalaya, Jaya Wijaya, and Andes), and low places (Phillipine Trench, Java Trench, and Banda Trench). Then ask participants why they can happen.

3. Use the tools and material to explain the above mentioned phenomena, and explain the earth's crust movement with the Plate Tectonic Theory.
4. Ask participants who among them have ever experienced, felt, heard or seen earthquakes and their consequences. Then ask a participant to share his/her experience in front of the class.
5. Divide the class into several groups. Conduct brainstorming with the groups to make a list of all events that happen during an earthquake, causes of earthquakes, show earthquake prone regions.
6. Use the above mentioned tools and material to explain earthquake events, the natural phenomena accompanying earthquakes, types, causes, hazards and disasters resulting from earthquakes.

Competence

Participants will be able to understand the definition of „earthquake", earthquake types, their causes and impact.

Indicators

Participants will in writing be able to:

1. Explain the definition of „earthquake",
2. Explain earthquake types according to their causes,
3. Explain the natural phenomena accompanying earthquakes,
4. Show earthquake prone regions in Indonesia on the map,
5. Explain the impact caused by earthquakes.

Background Information

A. Earthquake Definition

According to a legend existing among the traditional people, an earthquake is perceived as a natural phenomenon that destroys and causes disaster to humankind among others due to the writhing of an angry dragon thus shaking the earth violently up to its surface. There are many legends explaining the causes of earthquakes and they can be found in different countries, each region even has its own version. The explanations for the causes of earthquakes provided by legends cannot be proven scientifically at all. The legend exists because people were at that time still unable to explain the phenomenon of an earthquake in a scientific manner.

In the modern society with all its science and technological development, an earthquake can be explained in a scientific manner as a natural phenomenon such as rain, wind, etc. Earthquakes have been occurring for billions of years and are as old as the earth. „Earthquake" is a term used to describe both sudden plate displacement or

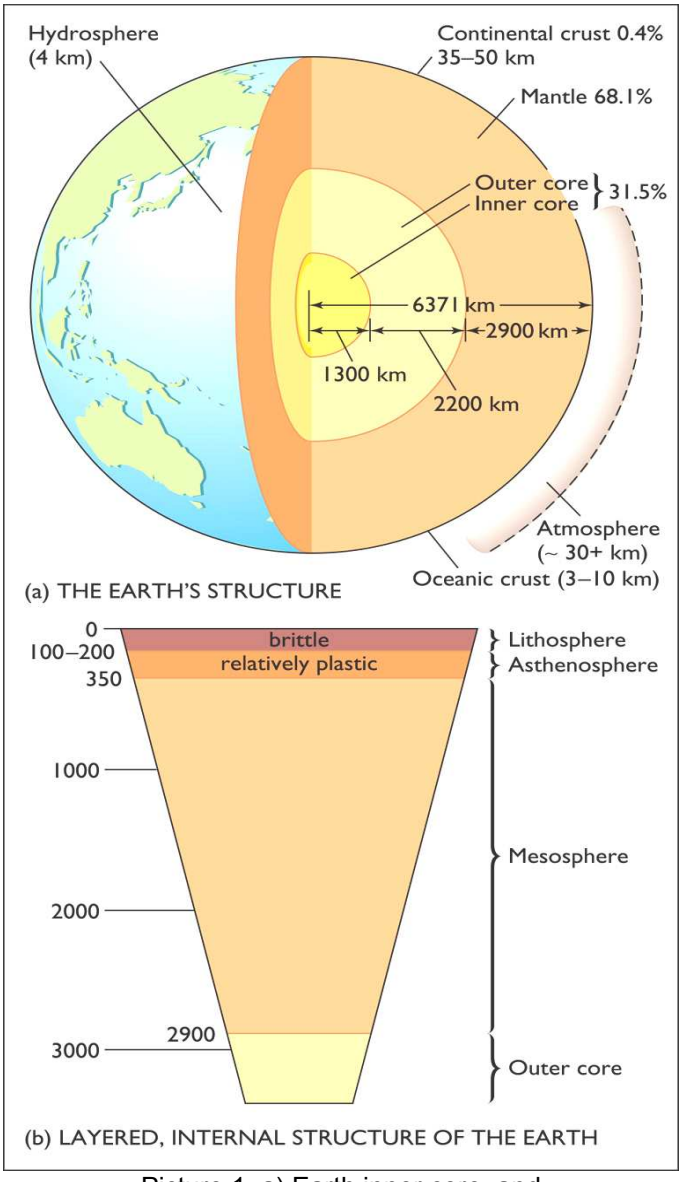
fault and the resulting ground shaking and radiating seismic energy caused by the displacement, or by volcanic activities, or other sudden stress changes in the earth.

B. Earthquakes and Plate Tectonic Theory

a. The Inner and Material Structure of the Earth

Before we learn more about the earthquake phenomena we ought to know about the material structure of our earth and what the earth's structure is like (Picture 1). Our earth has a radius of 6371 km, comprising:

- inner core (1300 km in thickness)
- outer core (2200 km in thickness)
- earth mantle (2900 km in thickness)
- outer crust, comprising continental plate (35-50 km) and oceanic plate (3.5-10 km)



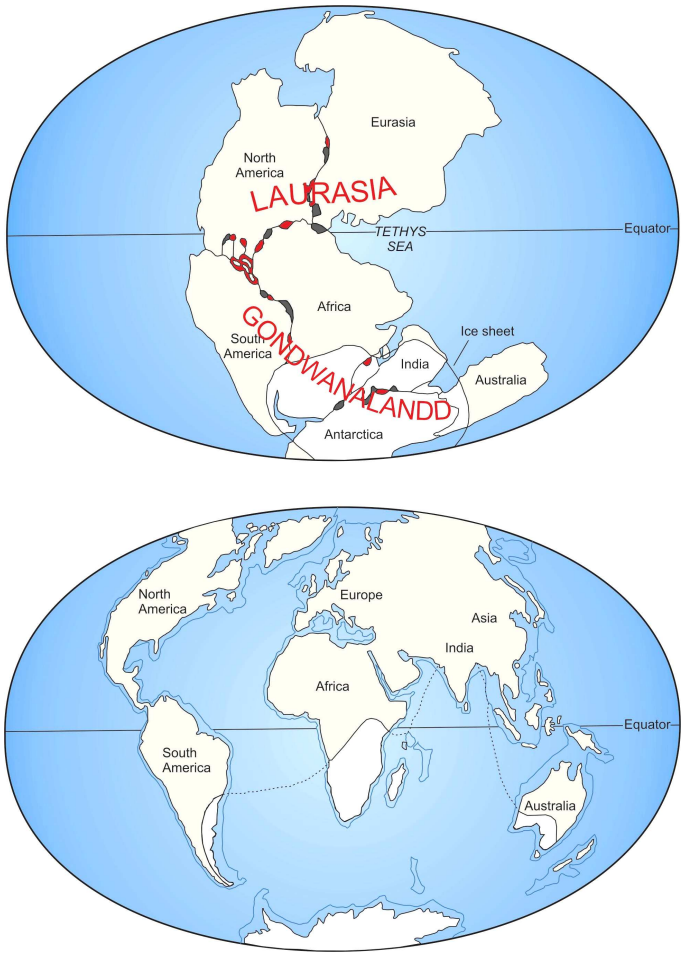
Picture 1 a) Earth inner core, and
b) Earth inner layers (Kenet, 1982).

b. Plate Tectonic Theory

The Plate Tectonic Theory states that the earth's crust composes of several large, thin, relatively rigid plates that move relative to one another. This theory was introduced for the first time by a German astronomer, Alfred Wegener in 1915, known as „Continental Drift". At first this theory was rejected as it failed to explain the cause of the earth's crust's movement. Only after new geological data was discovered, did this theory reemerge in the 1960s as the Plate Tectonic Theory.

c. Continental Drift

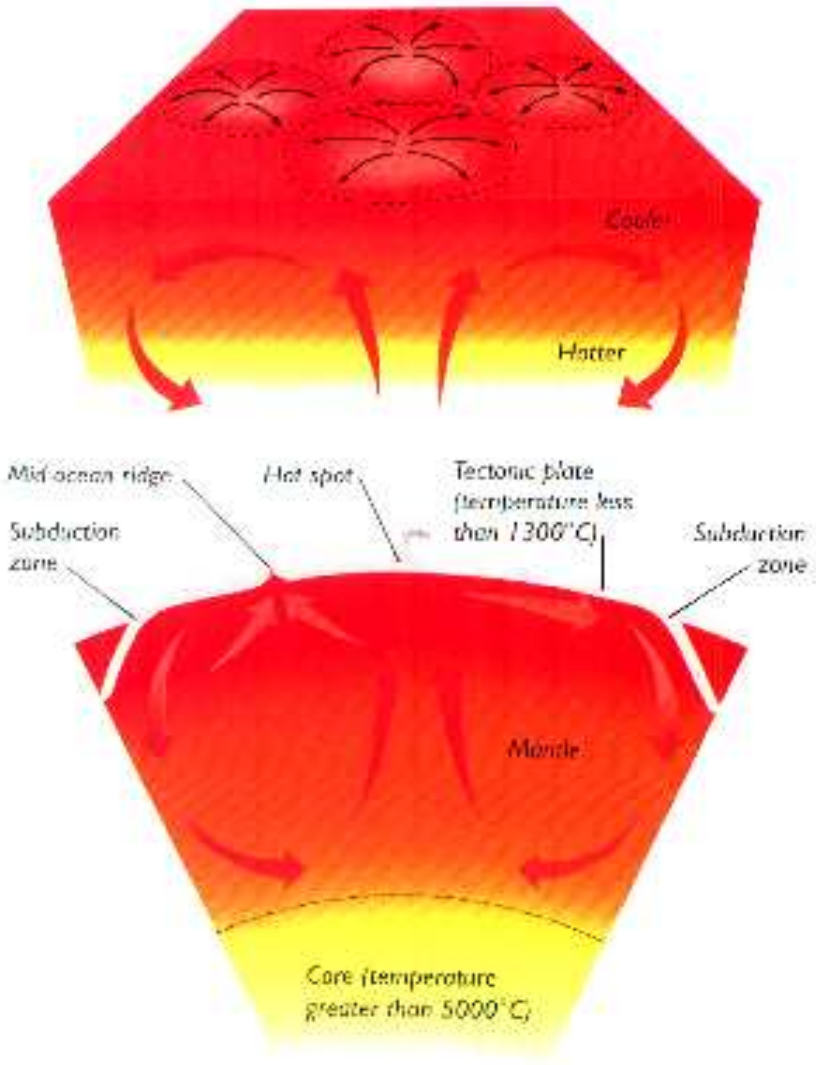
The continents on the surface of the earth when moving closer can fill each other place as if there is only one continent and one ocean on the earth's surface. This inspired the continental drift theory, which states that this earth's surface originally comprised one continent and one ocean, and due to some process had broken apart and then sided apart from each other, sided towards each other, and grinded past each other. In simple term the Continental Drift theory explains that the earth's crust is like plates drifting atop of the underlying mantle (Picture 2).



Picture 2 Above: earth's surface condition (200 million years ago) when still comprising one continent and one ocean, and below: current condition (Kenet, 1982).

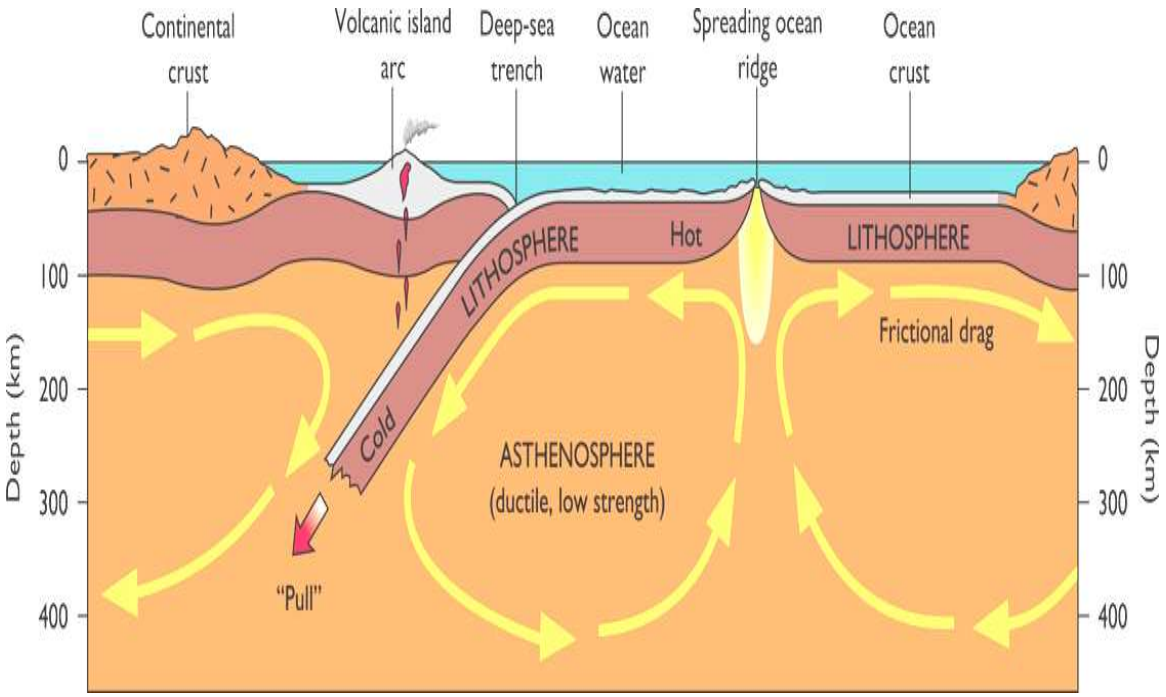
d. What makes the earth's crust move?

The movement of the earth's crust (tectonic plates) is caused by convection currents. Convection currents occur when mantle rocks near the core melt, so that they have less gravity than the cooler, upper mantle rocks. These warmer rocks rise while the cooler rocks sink, creating slow, vertical currents within the mantle. This movement of warmer and cooler mantle rocks in turn, creates pockets of circulation within the mantle called convection cells. The circulation of these convection cells is the driving force behind the movement of the earth's crust (Pictures 3 and 4).



Picture 3 Convection currents. Rocks near the core are heated and rise. Thereafter the rocks become cooler and sink again. The vertical movements of these rocks create convection currents (Seiver, 1986).

Convection currents cause the earth's crust to move. These movements may be pulling apart, moving together, and sideswiping. Pulling apart of the earth's crust is called „Sea-floor Spreading". A famous example of this phenomenon is the pulling apart of Africa from South America whereas the earth's crust that is moved together or crushed together is called "subduction" or "plate collision". An example of plate collision is the colliding of the India-Australian plate against the Asian plate which is called Java Trench stretching from near the western part of Sumatra, southern part of Java, southern part of Nusa Tenggara until the Maluku archipelago. while sideswiping or "transform fault" can be found near Sulawesi and Papua (Picture 5).

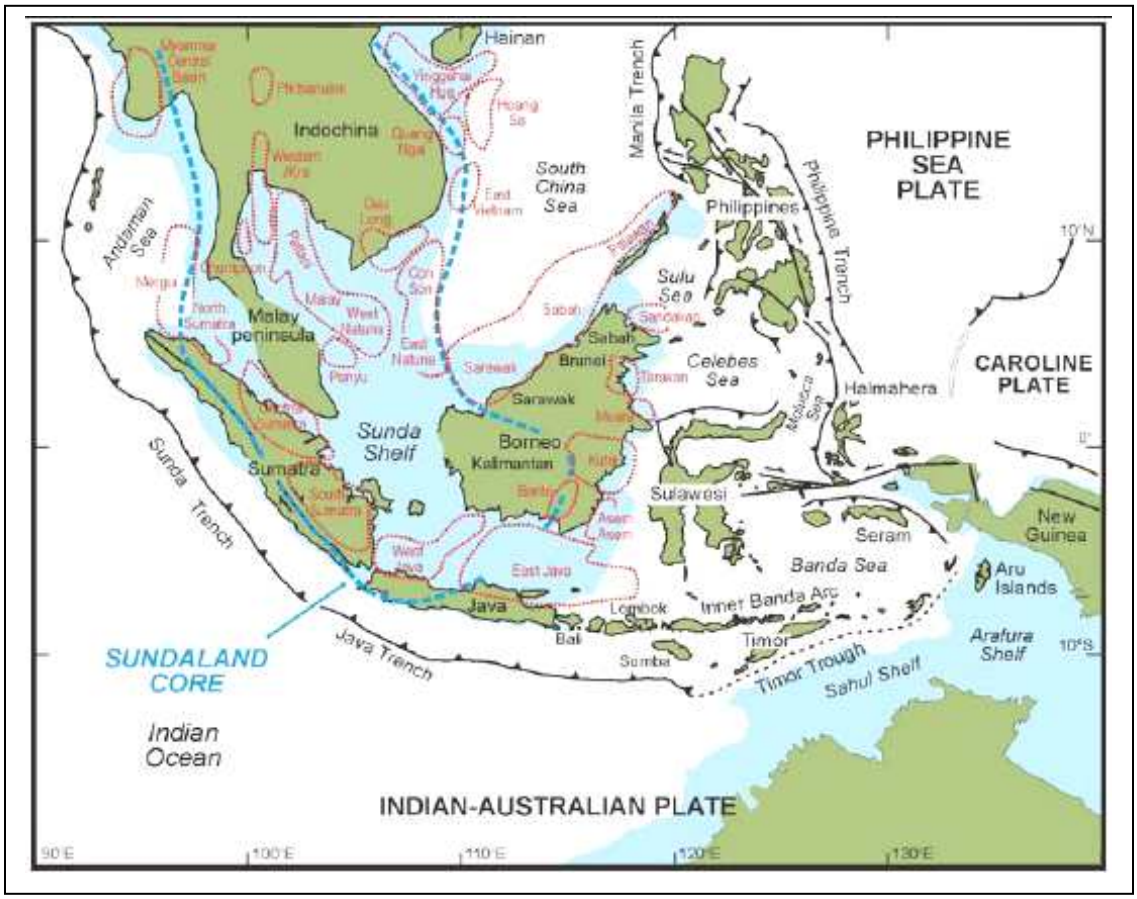


Picture 4 Convection currents causing collision between plates at one location and oceanic bed spreading at another location (Seiver, 1986).

e. Earthquake Causes

Until now it is believed that earthquakes are caused by the movement of tectonic plates. Moving plates due to pressing and pulling energies cause energy accumulation within the rock masses. When the carrying capacity of the rock mass is exceeded it may fault. The fault will cause a sudden energy release that when reaching the surface is called earthquake which when quite severe may cause disaster.

Apart from faults due to movement of the plates or earth's crust, an earthquake may also occur because a volcano is about to erupt or because of a mining avalanche. But an earthquake caused by a volcanic activity or an avalanche is usually not severe, very seldom, occurs locally and rarely results in a disaster.



Picture 5 Tectonic map of Indonesia that shows collision tracks between Indian and Asian plates and the grinding of other plates (Hall, 2003).

C. Earthquake Magnitude

The magnitude of an earthquake can be noticed from how large the release of energy is or how high its destruction level is. The earthquake's magnitude as regards to energy refers to the quantity of energy released and is dependent on fault size, and seismograph recording according to the "Richter scale".

An earthquake's intensity refers to how severe the earthquake is felt by the observer and refers to a qualitative earthquake damage assessment. The earthquake's intensity scale is dependent on the distance and intensity of the earthquake, tremor velocity, and the damage it has caused.

The intensity scale is an illustration of how severe the destruction is experienced by a certain location due to the earth's shaking. The intensity scale used in Indonesia is the "Modified Mercalli Intensity" (MMI). Table 1 presents the intensity scales in Roman figures depicting the higher the figure the more severe is the destruction suffered by a particular location.

Table 1 Earthquake's intensity scales according to MMI

Intensity Scale	Condition of Location and Destruction Level
I	Vibrations can't be felt except by sensitive recording equipment and in an extraordinary condition by certain persons only
II	Vibrations can only be felt by certain persons. Slight shaking of suspended light goods
III	Intensive vibrations felt inside buildings as if a truck has passed by
IV	Felt during the day by many people inside buildings, felt by certain persons only outside buildings. Objects scattered in pieces, squeaking windows and doors. Cracking walls
V	Vibrations felt by almost everyone in a particular location. Objects scattered in pieces, broken glass windows, goods crashing down, shaking trees and pillars
VI	Vibrations felt by everyone, shocking most of them and making them flee out of buildings. Walls tumbling and factory chimneys damaged. Damage still considered slight.
VII	Everyone fleeing from buildings, slight damage to houses and buildings, cracking smoke chimneys. Vibrations felt by people inside vehicles
VIII	Slight damage to well structured buildings. Multitude of cracks on buildings. Walls, smoke chimneys, and monuments tumbling down
IX	Damage to well structured buildings, slanting houses. Numerous cracks on walls of sturdy buildings. Buildings shifting from foundations. Underground pipes leaking
X	Damage to strong wooden buildings, houses collapsing, ground fissures, bent rails, landslides, tsunami waves
XI	Only few houses remain standing, bridges collapsing, ground fissures, landslides, broken pipes, and bent rails
XII	Total destruction. Earthquake waves noticeable along earth's surface. Dark scenery. Objects are flung in the air

Source: Latha (2004).

Table 2 presents the correlation between an earthquake's magnitude according to the Richter scale and the damage intensity.

Table 2 Correlation between Richter scale and Earthquake Intensity (2004).

Magnitude (Richter Scale)	Intensity
1-3	Generally not felt but recorded in local seismograph
3-4	Can often be felt but does not cause damage
5	Widely felt, slight damage near epicenter
6	Damage to poor constructed buildings within a radius of 10 km from epicenter
7	Large earthquake, causing severe destruction within a radius of 100 km
8	Huge earthquake with severe damage resulting in deaths until a radius of 100 km
9	Gigantic earthquake with terrible damage to vast regions of more than 1000 km, but probability of occurrence is rare

D. Earthquake Types

Earthquakes can be distinguished into several types according to the causes/sources, hypocenter, and distance from the epicenter. The definitions of hypocenter and epicenter can be read at the end of this module under „important terms".

a. Types of earthquakes according to their causes/sources

1. Tectonic earthquake

A tectonic earthquake refers to an earthquake caused by the movement of tectonic plates. Tectonic earthquakes are the most frequent of all and affect vast areas.

2. Volcanic earthquake

A volcanic earthquake occurs due to a volcanic activity that is erupting or will erupt. These earthquakes happen locally, and only affect the surroundings of the active volcano with a mild tremor.

3. Earthquakes caused by avalanches

These earthquakes occurs because of an avalanche beneath a mine's surface. This earthquake seldomly occurs and the tremor is mild.

b. According to the earthquake's hypocenter

1. Shallow (< 50 km)
2. Medium (50-300 km)
3. Deep (>300 km)

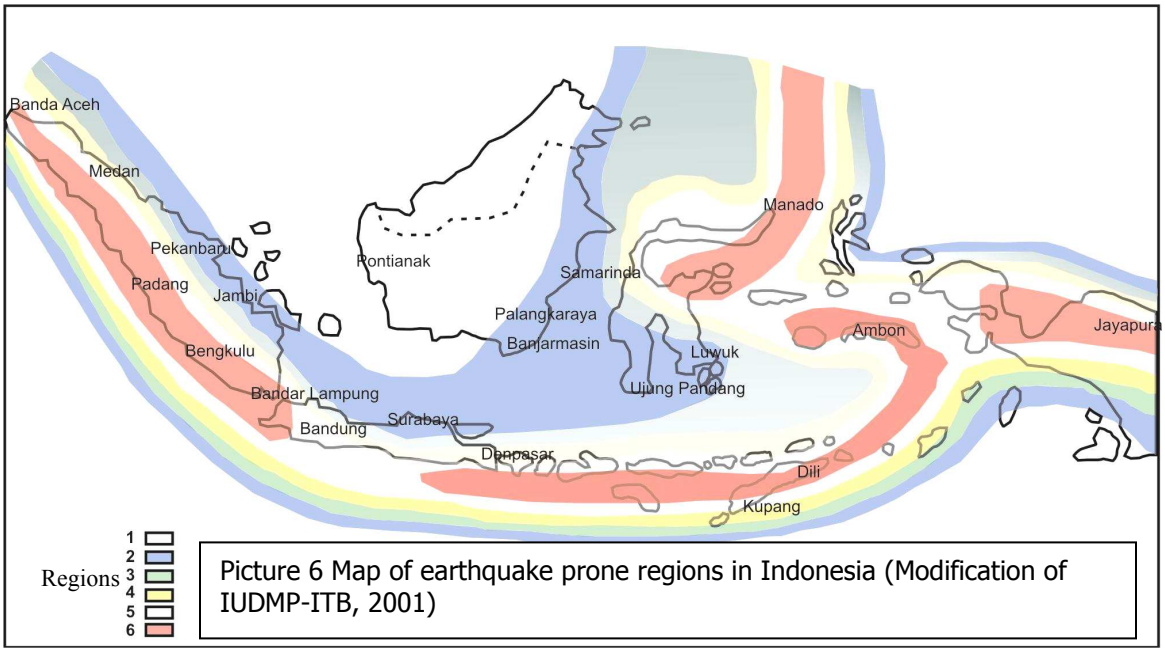
c. According to the distance from the epicenter

1. Local (< 100 km)
2. Remote (100-300 km)
3. Very remote (> 300 km)

E. Earthquake prone regions in Indonesia

The Indonesian archipelago forms a collision zone of three large world plates, i.e. the India-Australian plate from the south, the Eurasian (South East Asia plate) plate from the west and east, and the Pacific plate from the east, as well as small plates such as the South China Sea plate and the Philippine plate from the north. Therefore geologically the condition in Indonesia is very intricate and it is the place on the earth's surface with the highest frequency of earthquakes.

The majority of regions in Indonesia, especially the western part of Sumatra, the southern part of Java, Bali, Nusa Tenggara, Maluku, Papua, and Sulawesi are potential earthquake regions and are vulnerable against disasters caused by earthquakes (Pictures 5 and 6). Why are those regions vulnerable against earthquakes? The reason is that they are in the vicinity or very close to the location of the earth's crust's movement, as the earthquake's source



Picture 6 Map of earthquake prone regions in Indonesia (Modification of IUDMP-ITB, 2001)

Picture 6 shows Indonesian regions with different vulnerability levels. The division from 1 to 6 represents regions ranging from the lowest vulnerability level to the

highest vulnerability level. Kalimantan belongs to region 1 which means it is spared from earthquake disaster because earthquakes rarely or almost never occur there. On the contrary, regions ranging from the western part of Sumatra, southern part of Java, Bali, Nusa Tenggara, Maluku, to Papua which are shown in red, belong to region 6 as the regions are most vulnerable against earthquake disasters.

F. Impact of Earthquakes

Earthquake shaking and vibrations can endanger human life as they are capable to straight away topple down structures, buildings, and houses. Earthquakes may also indirectly endanger humans because earthquake shaking and vibrations are capable of causing events that trigger other events resulting in disasters.

Hazard resulting from earthquakes

When an earthquake strikes, it is usually followed by natural phenomena and/or events that endanger or have the potential to cause disasters. The probability of natural phenomena or events is among others:

1. Ground motion: Ground motion can shake buildings until they topple down.
2. Liquefaction: a process changing initially stable soil into water saturated or fluid sediment, which may cause damage to the buildings on its surface.
3. Landslide: earthquake vibrations can trigger soil movement, such as landslides.
4. Fire: earthquake shaking and vibrations can damage electrical installations and gas pipes which may trigger large fires.
5. Tsunami: faults under the seabed due to a huge earthquake can cause gigantic waves following an abrupt displacement or formation change of plates under the seabed.

Damage resulting from earthquakes

Earthquakes may have various effects, including changes in geological sighting (valleys or ground fissures), damage to man-made structures and impact on the life of humans and animals (Picture 7). A disaster occurs if an earthquake causes damage, the more intense the damage is, the more severe the resulting disaster will be.

Severe or slight damage to buildings resulting from earthquakes is dependent on many factors, among others:

1. **Earthquake size**

    - The larger the earthquake size the more intense it will cause damage.

2. **Distance from earthquake epicenter**

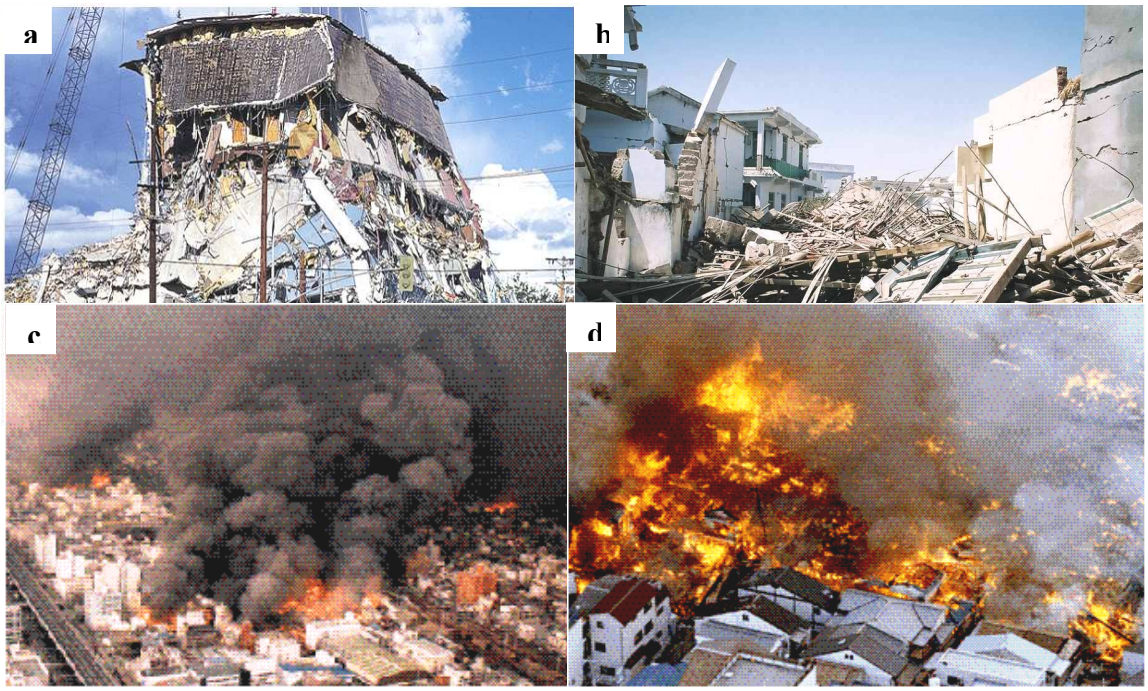
    - The nearer the disaster location is to the earthquake epicenter, the greater the damage level will be.

3. **Nature of material or soil at location**

- Loose soil such as still soft river sediments and volcanic deposits, may accelerate an earthquake's velocity and thus raise the damage level.

4. **Condition of structures and buildings in the area**

- Wooden buildings with strong foundations are more resistant against earthquakes, whereas buildings that are not structured from reinforced concrete material are vulnerable against earthquake shaking.



Pictures 7 a) and b) Buildings turning into rubble as a direct result of earthquake shaking, c) and d) Fire resulting from a damage to electrical installations and gas pipes caused by earthquake shaking (Latha, 2004).

Learning Activities

A. Tools and Material

The tools needed in this learning activity are:

1. Teacher's handbook (handouts)
2. Student Worksheet
3. Map dividing continents
4. Indonesian tectonic map
5. Map of earthquake prone regions in large size
6. Map of the world

B. Preparation

1. Instructor:
   Prepare handbook (handouts), prepare necessary maps
2. Students:
   Prepare handbook (handouts), prepare map of Indonesia, blank paper and writing material

C. Learning Steps

Initial Activities

Teacher shows pictures regarding natural disasters caused by earthquakes, and then asks:

1. ***What do you see on these pictures?***
2. ***What could have caused this damage?***

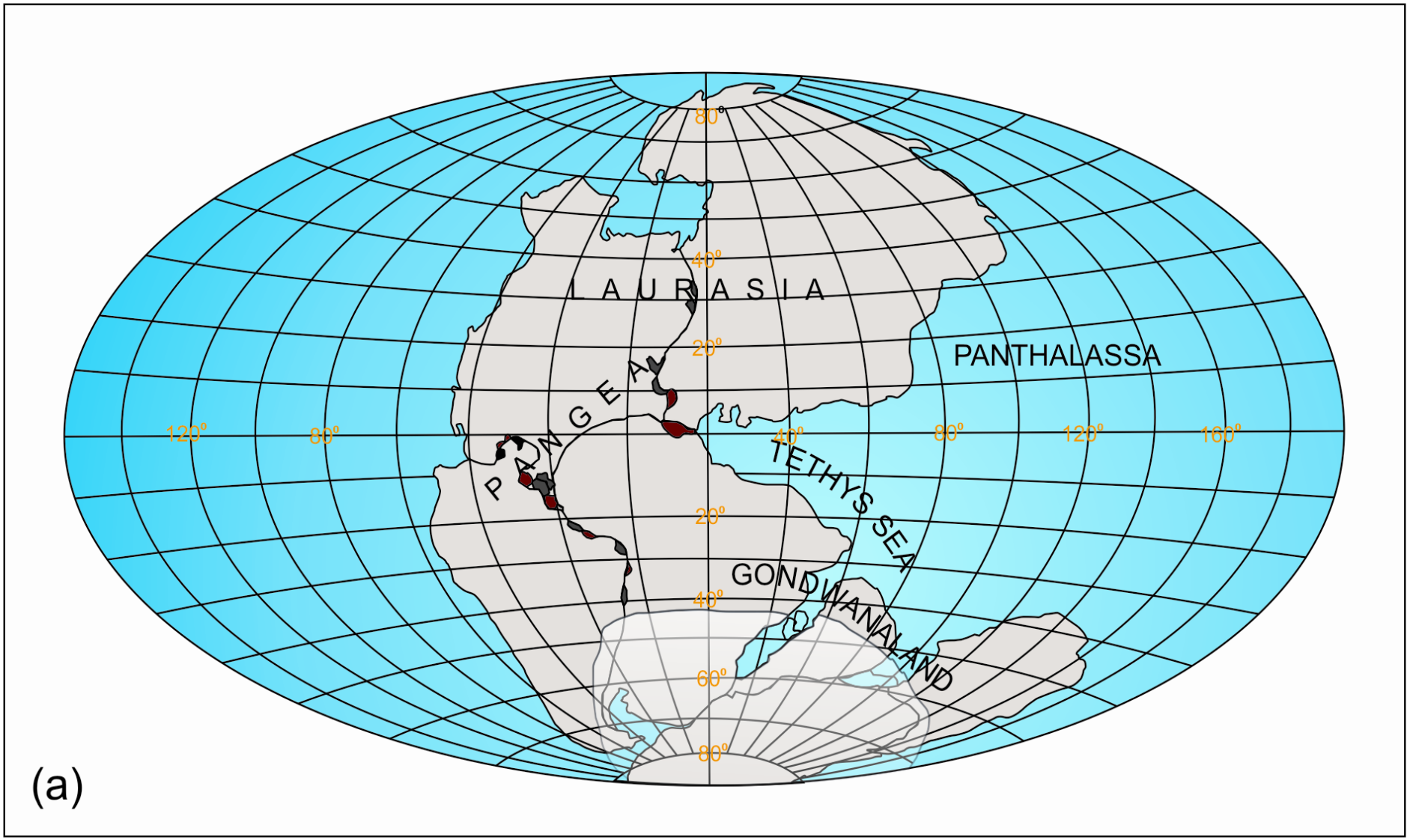
Students may give various answers, for instance due to wars, windstorms, floods, and earthquakes. The teacher should focus on the answers naming earthquakes as the cause of the damage.

Teacher asks students: ***„Who among you has ever experienced, felt, heard or seen an earthquake? "*** Then appoint one student to tell about his/her experience in front of the class.

Well, now we will learn how an earthquake occurs and what impact it is causing.

Core Activities

Teacher divides students into groups of four each and distributes maps (map dividing continents, map of the world, tectonic map of Indonesia, and map on epicenter spreading) to each group.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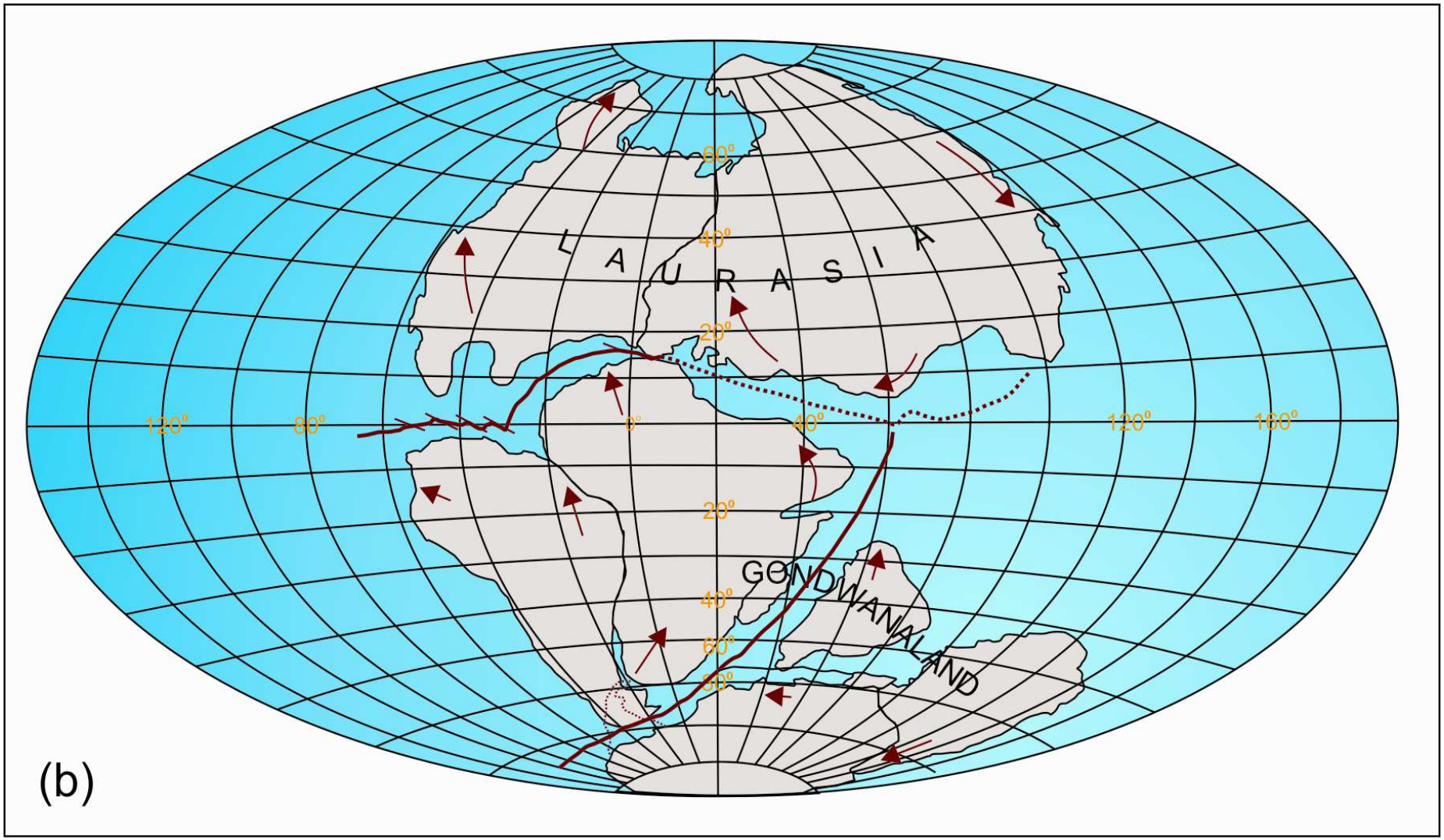
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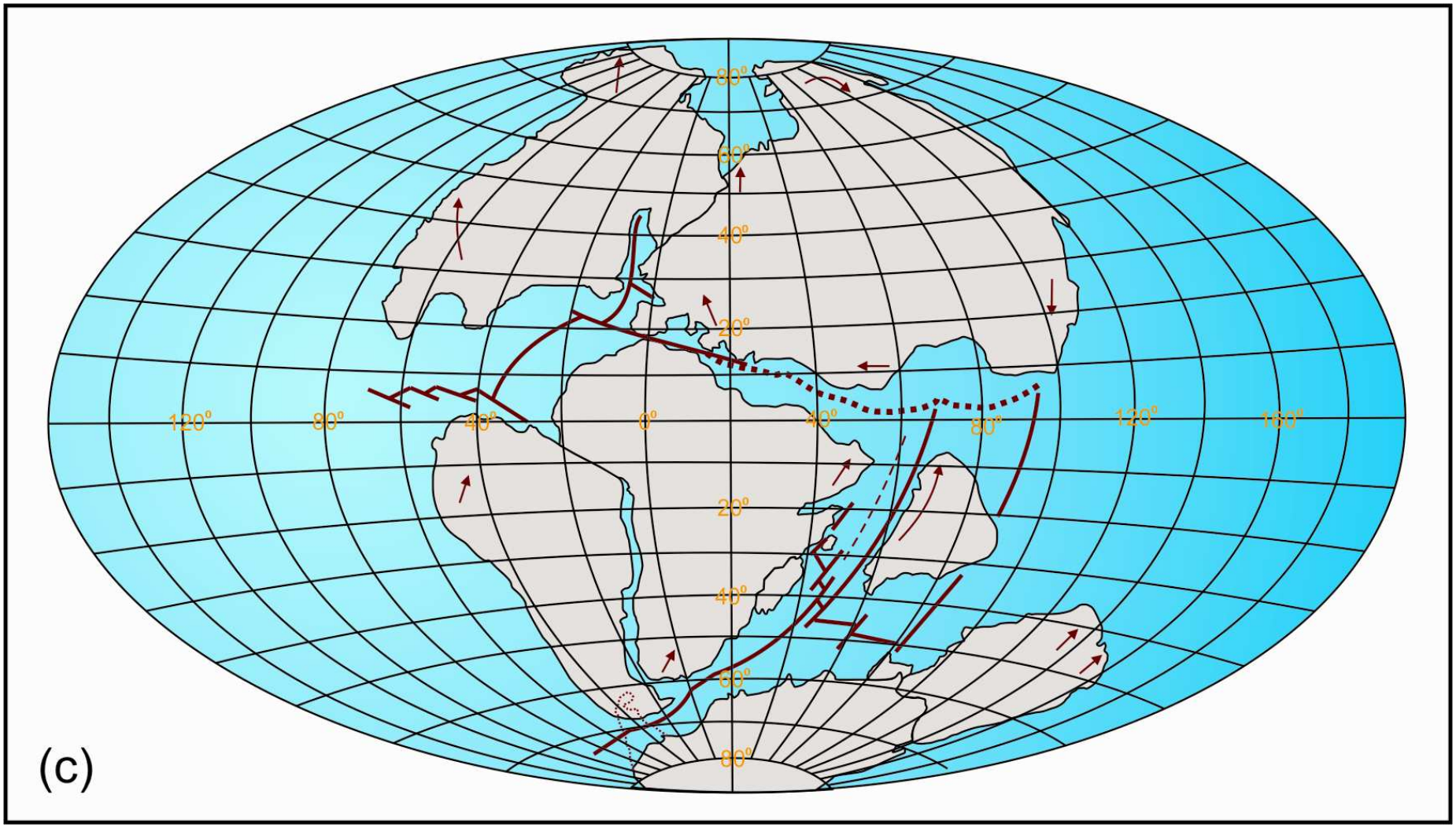
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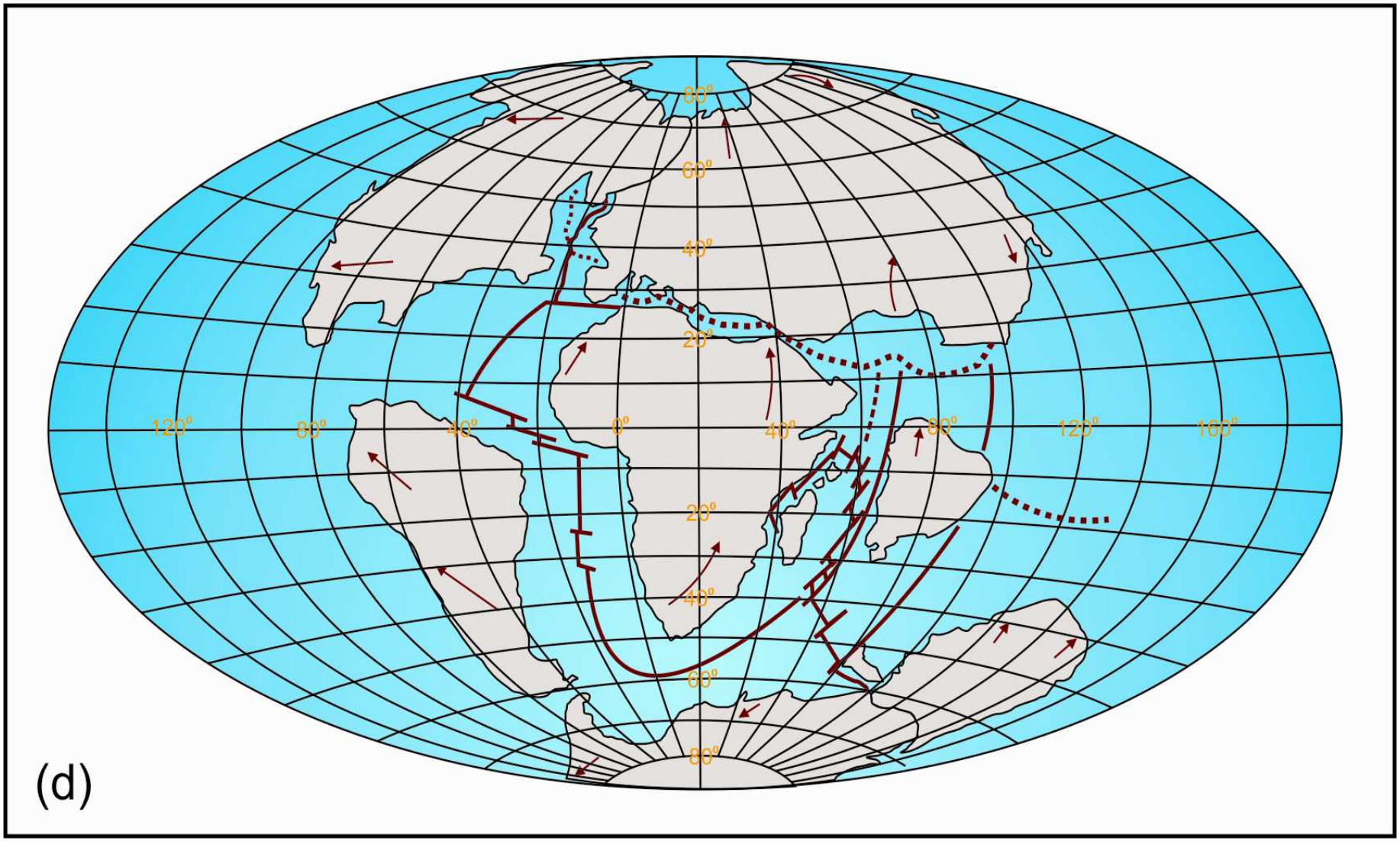
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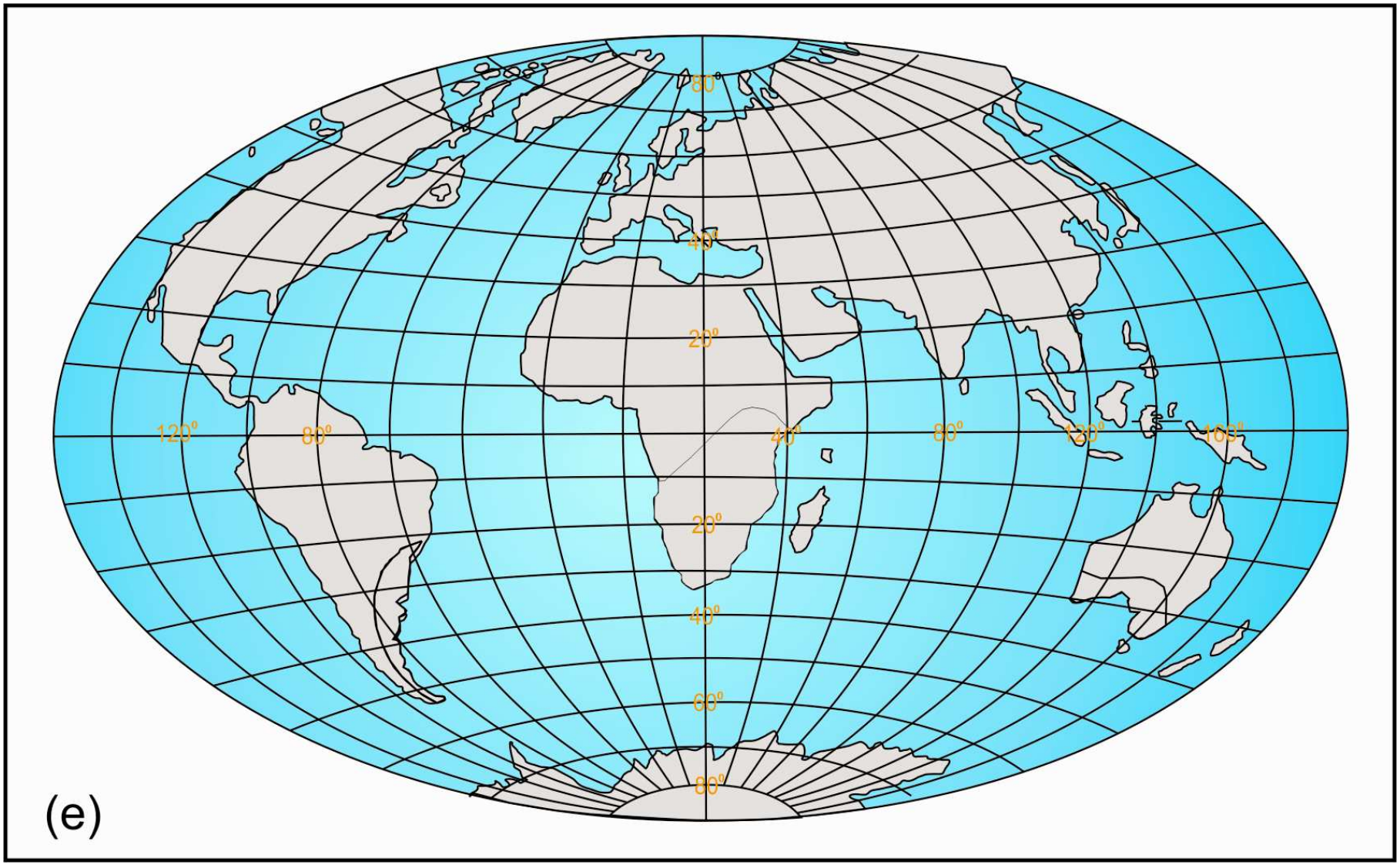
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Activity 1: Discussion on the Movement Source of the Earth's Crust

1. Students are requested to discuss the movement source of the earth's crust (division of continents) and the forming of high mountain ranges on continents and deep trenches in oceans within their groups.
2. Teacher asks the groups, each represented by one student to explain how the earth's crust can move and how the high mountain ranges and deep trenches are formed. Teacher asks what causes the earth's crust to move.
3. Teacher uses the tools and material as mentioned above to explain the phenomenon, and explains the source of the earth's crust's movement with the Plate Tectonic Theory.
4. After having explained the source of the earth's crust's movement and the driving force mechanism, the teacher asks each group to study the tectonic map and the map on epicenter spreading.
5. Teacher asks the groups, each represented by a student to explain the correlation between the tectonic map and the map on epicenter spreading.
6. Teacher asks each group whether there is a correlation between frequent earthquake regions and areas where plates collide, grinding faults, and sea-floor spreading.
7. Teacher explains the definition, types, and causes of earthquakes.

Activity 2: Discussion on Natural Phenomena Accompanying Earthquakes

Teacher distributes pictures or photos of ground shifting, ground fissure, fault, and tsunamis.

3. Teacher asks the groups to discuss the events shown in the pictures or photos among themselves.
4. Teacher asks the groups, each represented by one student to explain the correlation between the events on the pictures or photos (fault, ground fissure, and tsunami) and earthquakes.
5. Teacher explains how earthquakes can cause faults, ground fissures, and tsunamis.

Activity 3: Discussion on Earthquake Prone Regions in Indonesia

Teacher distributes the map of earthquake prone regions in Indonesia and the map of Indonesia to each group.

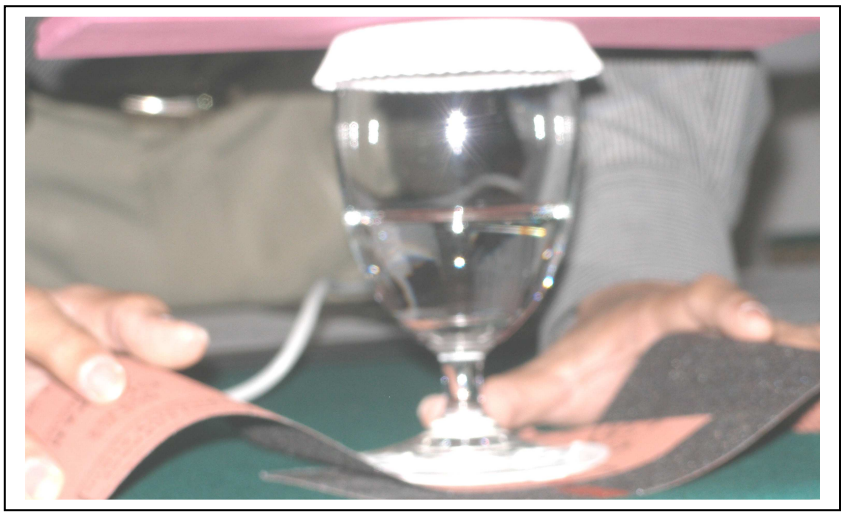
1. Conducts discussion and brainstorming to identify their school area as belonging to which district and located in which earthquake prone region. Teacher asks students to do the same thing with other big cities in Indonesia.

2. Asks students to point out their area on the map and identify what region their area belongs to. Teacher points out several big cities in Indonesia and asks each group to point out to which earthquake prone regions those cities belong.
3. Activity 2 informs the students that their area is an earthquake prone region.

Activity 4: Discussion on the Impact of Earthquakes

Teacher distributes pictures or photos of collapsed buildings, collapsed flyovers, ground fissures, landslides, fires and tsunamis.

1. Teacher asks the groups to have discussions amongst themselves regarding the events illustrated in the pictures or photos.
2. Teacher asks the groups, each represented by one student to explain the correlation between the events illustrated in the pictures or photos with earthquakes.
3. Teacher demonstrates how earthquakes happen by using a glass and sandpaper.



   a. Put the sandpaper down on the table, the rough sides together, overlapping each other about 5 cm.
   b. Place the glass on top of the overlapping area, fill it with some water.
   c. Put tension onto the sandpaper by pushing the two pieces together, holding the contraption at the right and left end.
   d. Demonstrate the effect that takes place when the friction reaches its maximum, by pushing the elevation of the sandpaper down onto the table.

Teacher explains the effects of earthquakes (how it causes the soil to move and how it can cause a tsunami).

Conclusion/Summary, Questions

a. An earthquake is an abrupt and rapid shaking and trembling of the ground caused by a huge energy release that follows the movement of the earth's crust stretching along fault tracks and/or the result of a volcanic activity.

b. The Plate Tectonic Theory states that the earth's crust is compiled of rigid plates which keep moving against each other.

c. The Continental Drift Theory explains that the earth's crust is like drifting plates that are always moving above the mantle.

d. An earthquake is caused by plate tectonic motion.

e. Earthquake types according to their cause:
   1. Tectonic earthquake
   2. Volcanic earthquake
   3. Earthquake caused by an avalanche

f. According to hypocenter:
   1. Shallow (< 50 km)
   2. Medium (50-300 km)
   3. Deep (>300 km)

g. According to distance from epicenter:
   1. Local (< 100 km)
   2. Remote (100-300 km)
   3. Very remote (> 300 km)

h. Majority regions in Indonesia especially the western part of Sumatra, southern part of Java, Bali, Nusa Tenggara, Maluku, Papua, and Sulawesi are earthquake prone regions and are vulnerable against disasters caused by earthquakes.

i. The shaking and vibrating of earthquakes can endanger humankind as they may straight away topple down structures, buildings and houses. Whereas earthquakes in an indirect manner can endanger humankind as earthquake's shaking and vibrations may trigger other events which may result in disasters such as landslides, fires, or tsunamis.

Important Terms

Hypocenter

- The point within or above the earth's surface where an earthquake rupture starts.

Epicenter

- The vertical projection from the hypocenter to the earth's surface.

Initial Earthquake

- A relatively small earthquake if compared to the main earthquake. A initial earthquake usually precedes a larger main earthquake.

Main earthquake

- The larger earthquake, compared to the initial eartquake as well as the aftershocks.

Aftershocks

- Are earthquakes that usually occur after the occurrence of a main earthquake with relatively lower shaking, compared to the main earthquake.

Seismograph

- Earthquake motion recording equipement.

Seismogram

- A record written by a seismograph in response to motions produced by an earthquake.

Assessment

A. Pre-assessment Survey

1. What do you know about earthquakes?
   a. Landslide
   b. Flood
   c. Abrupt shaking on the earth's surface occurring as a natural phenomenon.

1. When can earthquakes happen?
   a. During the dry season
   b. During the rainy season
   c. Any moment, day or night

2. Mention any occurrence or phenomenon that accompanies an earthquake!
   a. Heavy rainfall
   b. Windstorm
   c. Landslide, ground fissure and/or tsunami

3. Mention examples of disasters as the result of earthquakes!
   a. Collapsed buildings
   b. Droughts
   c. Floods

4. What can cause earthquakes?
   a. An angry dragon underneath the earth's surface
   b. Movement of the earth's crust
   c. Mining of ground oil from underneath the earth's surface

B. Post-assessment

1. What do you know regarding the Continental Drift Theory?
   a. Theory regarding the formation of planets
   b. Theory regarding earthquakes
   c. The earth's crust is like drifting plates which are always moving above the mantle.

2. Mention types of plate tectonic or earth's crust movement!
   a. Plates sliding towards each other or sliding apart from each other
   b. Plates grinding past each other
   c. Combination of answer a and b.

3. What do you know about earthquakes?
   a. Landslide
   b. Tsunami
   c. Abrupt shaking of the earth's surface as a natural phenomenon

4. When do earthquakes occur?
   a. During the dry season
   b. During the rainy season
   c. Any moment, day or night

5. Mention any occurrence/phenomenon that accompanies an earthquake?
   a. Heavy rainfall
   b. Windstorm
   c. Ground fissures, landslides and or tsunami

6. Mention examples of any disaster resulting from earthquakes?
   a. Collapsed buildings, landslides
   b. Fires.
   c. Combination of answer a and b

7. What causes an earthquake?
   a. An angry dragon underneath the earth's surface
   b. Earth's crust movement
   c. Mining of ground oil from underneath the earth's surface

7. Mention earthquake types according to their causes
   a. Tectonic earthquake, volcanic earthquake, earthquake caused by avalanche
   b. Local earthquake, remote earthquake, very remote earthquake
   c. Shallow earthquake, medium earthquake, deep earthquake

8. According to their causes, the most frequent earthquakes are:
   a. Volcanic earthquakes
   b. Tectonic earthquakes
   c. Earthquakes caused by avalanche

9. Among the regions mentioned beneath the most frequent earthquakes occur in:
   a. Central Kalimantan
   b. Eastern coast of Sumatra
   c. All along the southern coast of Java

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Module 3 Early Symptoms of Earthquake Disasters and Measures that should be Taken

Competence

Participants will be able to understand the early symptoms of earthquake disasters and measures that should be taken in anticipation.

Indicators

1. Participants will be able to explain early symptoms of earthquakes, both artificial and natural.
2. Participants will be able to identify the results caused by earthquakes.
3. Participants will be able to explain the measures that should be taken to anticipate earthquake disasters.
4. Participants will be able to explain the measures that should be taken in the framework of realizing preparedness.

Background Information

An earthquake is a natural phenomenon in the shape of ground shaking or trembling caused by vibrating sources inside the earth resulting from (UNDP, 1992):

- Fault or displacement of rock mass due to tectonic activities
- Volcanic eruption due to volcanic activities
- Falling material from outer space (among others meteorites and asteroids)
- Nuclear bomb eruption due to human behavior (artificial)

Thus based on their cause two types of earthquakes exist i.e. natural earthquakes and artificial earthquakes. Natural earthquakes that frequently occur are tectonic earthquakes and volcanic earthquakes. Tectonic earthquakes occur most frequent and cannot be forecasted until now, whereas their huge power and high intensity can result in huge and fatal disasters. This paper will only focus on tectonic earthquakes.

The natural phenomenon of this earthquake type is its sudden and irregular occurrence. Therefore, since efforts to predict until now are still unsuccessful, the best and most appropriate effort to anticipate is by taking preventive measures through planning measures that should be taken before and after the occurrence. Disaster management before the occurrence is among others mitigation and preparedness.

Mitigation refers to measures and activities to reduce the losses and risks emerging from disasters. Preparedness refers to activities before disasters occur so that casualties can be minimized.

A. Early Warning System

In earthquake disaster management, it is very important to initiate an early warning system because by knowing symptoms earlier, there will be more time to avoid earthquake risks.

To identify early earthquake symptoms, we can refer to natural symptoms and seismogram records.

1. Natural symptoms

Natural symptoms preceding earthquakes are often quite easy noticed by people, which are even more accurate. Natural symptoms include: anomalies in animal behavior and habit. Usual loud animals become silent. However these natural symptoms are quite inaccurate as there were cases where animals did not show any behavior change at all before earthquakes. These natural symptoms are being investigated further by experts.

2. Artificial symptoms

Artificial symptoms may be obtained out of analysis results of earthquake measurement and recording by the use of seismographs. A seismograph is an earthquake measuring equipment, starting from weak vibrations until very strong vibrations. An earthquake disaster will occur if the vibrations are very strong (velocity >7 RS). At the earthquake observation post, this vibration measurement is conducted continuously every day for 24 hours. Therefore there is a lot of seismic vibration measurement data. Data analysis results may take the shape of intensity, frequency, and pattern of vibrations during a certain period. Based on these results it is possible to formulate an earthquake probability pattern for use as basis for forecasting.

B. Measures to anticipate earthquake disasters

An earthquake occurs abruptly and lasts for a relative short period. The disaster strikes a relative limited area when compared to areas spared from disaster. However results may be fatal, and therefore may require a disaster management that is smart, efficient, and effective (Kirbani, 2001).

The system operational procedures for an earthquake disaster management that is smart, efficient, and effective, should include:

a) Analysis of the history of local earthquake disasters from time to time, the longer the time stretches the more accurate is the data.
b) Drawing a map of earthquake prone regions referring to topographical, geological and tectonic maps.
c) Monitoring constantly all earthquake events by establishing a network of feasible and adequate seismic observation posts.
d) Conducting comprehensive scientific analysis every time an earthquake occurs even though it did not cause any damage.

e) Increasing alertness every time there are anomalies or deviations from normal conditions, both in the increase and decrease of activities, because both may represent the symptom for occurrence of a larger earthquake.
f) Developing a reliable and operational decision making coordinating system, which is supported by a decision support system appropriate to the local environment with fatality risk levels and uselessness measurement.
g) Following-up agreed decisions with actual measures without any doubt.
h) Conducting an earthquake disaster management operating evaluation in line with the actual events at the locations.
i) Improving earthquake disaster management in a proactive and constant manner, to become truly prepared when facing future disasters.

C. Measures to realize alertness

The handling of earthquake disasters includes three phases, i.e.

1. Before an earthquake occurs, with concentration on preventive activities and initial warning systems.
2. During an earthquake disaster, with concentration on rescue efforts and evacuation of victims to minimize the loss of human lives.
3. After occurrence of an earthquake, with concentration on damaged infrastructure rehabilitation efforts and rehabilitation of spared victims.

Measures to realize alertness are taken before an earthquake occurs. Those measures the following:

1. Constructing a map of earthquake prone regions,
2. Socializing the map of earthquake prone regions,
3. Conducting training on preventive and mitigating measures of earthquake disaster impact,
4. Drawing designs and samples of houses and other buildings resilient against earthquakes,
5. Developing a smart, operational, efficient, and effective decision making process system (referring to decision making matrix see Table 2).

   In order that dealing measures of earthquake disasters can be effected in an optimized manner, these measures should be based on the magnitude of earthquakes so as to prevent uselesness in dealing with or even possible fatalities.
   There are 4 earthquake categories, i.e. small, medium, large, and very large. An earthquake is considered small if the intensity is less than 3 on the Richter scale, a medium earthquake's intensity is 3.5 on the Richter scale, large earthquake's intensity ranges between 5 and 7 on the Richter scale, whereas a very large earthquake's intensity is above 7 on the Richter scale. The correlation among earthquake categories, the Richter scale and MMI scale can be seen in Table 1.
6. Developing and improving earthquake early warning systems/disaster estimates.

Table 1 Earthquake Categories

No.	Earthquake Category	Richter Scale
1	Small	< 3
2	Medium	3 - 5
3	Large	> 5 - 7
4	Very large	> 7

The dealing measures also comprise 4 categories starting from no measure, alertness, temporary evacuation, until permanent evacuation (relocation). Measures taken should be proportional with the intensity of occurring earthquakes. If measure is not proportional, it may result in fatality or uselessness (Table 2).

Table 2. Matrix for formulating a smart, operational, efficient and effective decision making process system (Modification of Kirbani, 2001).

Earthquake / Measures	Small Earthquake	Medium Earthquake	Large Earthquake	Very Large Earthquake
Permanent Evacuation	Useless	Excessive	Not necessary	Accurate decision (optimized)
Temporary Evacuation	Excessive	Not necessary	Accurate decision (optimized)	Inaccurate
Alertness	Not necessary	Accurate decision (optimized)	Inaccurate	Inappropriate
No measure	Accurate decision (optimized)	Inaccurate	Inappropriate	Fatal

With regard to schools and households, alertness measures to ascertain that housing structures and layouts can spare people from disasters caused by earthquakes, landslides and avalanches are as follows:

1. Evaluate and renovate housing structures to avoid earthquake disasters.
2. Memorize the location of doors, emergency stairs, and other things inside the house to find the safest place for taking shelter in the event of an earthquake.
3. Conduct training of the use of fire extinguishing equipment.
4. Prepare important telephone numbers that can be contacted in the event of an earthquake.
5. Arrange cabinets to be fastened to walls to prevent them from toppling down during an earthquake event.
6. Store easily flammable material in safe/sturdy places to prevent the containers from breaking into pieces and avoid fire hazard.
7. Switch off electricity and gas when not in use.
8. Rearrange heavy material to be stored at lower places to reduce risk of it falling down on people.
9. Rearrange the stability of hanging objects such as decoration lamps and framed paintings to prevent them from falling down during earthquakes.
10. Keep medicine boxes, flashlights, radio, food supplements, and water ready.
11. Conduct training in administering first aid during accidents.

Learning Activities

Tools and Material

- Pictures of the impact of earthquakes (refer module 2)
- Pictures of tsunami disasters (refer module 2)
- First Aid Kit
- Pictures of how to take shelter (refer module 2)
- Pictures of how to evacuate (refer module 2)

Initial Activities

1. Teacher explains that earthquakes lately have occurred in several places such as Aceh, Nabire, Nias, and Padang resulting in vast casualties both on property and human life. Teacher asks the students: ***„Why didn't people in those places move to other places where there aren't any earthquakes? "*** The answers given by the students are not straightaway responded to by the teacher.

2. Teacher redirects student answers that ***people did not move away because they did not know when the next earthquake would occur.***

3. Then teacher says: ***because we are unaware of the symptoms when earthquakes are about to occur, what measures should we take to mitigate disaster risks?***

Core Activities

1. Teacher explains that Indonesia is an archipelago country with geographic condition located in the collision zone of the Eurasian, Indo-Australian, Philippine continental plates and the Pacific oceanic plate which is vulnerable against earthquakes. Teacher briefly explains about earthquake occurrence.
2. Teacher explains that before a child falls sick, there are symptoms which can be observed, for instance rising body temperature, headache, vomiting, etc. How is it with earthquakes, are there early symptoms? Student answers are collected, and teacher says: let us discuss this matter.
3. Teacher explains about natural phenomena, such as anomalies in animal behavior in certain earthquake prone regions.
4. Other than natural phenomena, there are also artificial symptoms resulting from seismogram observations. Teacher explains the Richter scale and its definition.
5. Teacher summarizes the early earthquake symptoms, both natural and artificial.
6. Teacher proceeds learning activity. During the occurrence of an earthquake, what happened/what did you see according to your experience? Teacher writes student answers on the white board, discusses and concludes. Teacher then shows pictures regarding disasters resulting from earthquakes.
7. If an earthquake occurs, naturally we don't want to become victims. The problem is what should we do to be spared from the disasters resulting from an earthquake? The students are given time to discuss in pairs, and results are written on the white board, to be discussed and concluded.

8. In order that the measures are not useless, teacher explains Table 2 regarding decision making.
9. In order to be spared from the danger resulting from earthquakes, what kind of preparedness will be necessary? This issue can be discussed through group discussion or class discussion. Discussion results are summarized and written on the white board.
10. Teacher summarizes the learning results from the beginning to the end through questions and answers.

Closing

Teacher closes the learning activity by giving an assignment to the students to collect information regarding earthquakes.

Evaluation

1. Please explain early symptoms, both natural and artificial regarding an earthquake that is about to occur.
2. Please make a list of results during an earthquake occurrence.
3. Please explain how to anticipate results caused by earthquakes.
4. Please explain measures and preparations to anticipate earthquake occurrence.

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